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PREHISTORIC ARCHEOLOGY, PAST, PRESENT AND FUTURE[1]

By N. C. NELSON

AMERICAN MUSEUM OF NATURAL HISTORY

PREHISTORIC archeology as a method of solving the problems of man's physical origin and cultural development may be traced back almost two hundred years, but it was not until past the middle of last century that the inquiry became a recognized science. The long interval is marked by several important discoveries, as well as by sporadic efforts to get systematic investigations under way; but, owing to the long established adverse speculations of poets and book scholars, little headway was possible in the observational field until after 1859, when the growing prestige of the natural science movement finally swung the balance in favor of the visible facts and so opened the road to free inquiry. Since then the spade has been steadily in service, and by degrees the earth has yielded up an abundance of relics in nearly every quarter. Interpretation of the evidence thus obtained has kept close pace and is continually being rectified as new facts accumulate. The outstanding results of these research activities are that in the short span of seventy-five years the story of human existence has been stretched from the 5,000 years or so covered by written documents to a million years or more and we are beginning dimly to see the general course of progress from near the time when man first took to making implements and thereby differentiated himself once and for all from the rest of animal creation. The picture may never be fully developed as to its minor details, but the grand outline is permanently fixed and is clear enough for any school child to see and appreciate. Under the circumstances, if the astronomers are permitted to startle us with their idea of a rapidly expanding physical universe, there is no

[1] Address of the vice-president and chairman of the section on Anthropology, American Association for the Advancement of Science, Atlantic City, December, 1936.

reason why the archeologists should not be allowed to point with equal pride to a similarly expanding human world.

The story of this archeological feat has not yet been adequately told. Zeal for gathering facts for and fitting the same into the general scheme of culture history has tended to obscure latent interest in the progress of the investigation itself. The lack is explainable also by the fact that the work until near the beginning of the present century was done as a rule not by seasoned professionals but by amateurs—men and women from every walk of life, scholastically trained and otherwise. This understandable universal appeal of things prehistoric has naturally been a mixed blessing. On the one hand, much of the earlier collected data are without accompanying information and therefore of comparatively little scientific value. On the other hand, the differently trained non-professional workers have contributed a great deal in the way of varied keen observations which are now embodied in archeological technique and which have helped to place the investigation on a broad and sound basis. Out of all this, in the natural course of events, professionally trained teachers and workers have lately come forth, prepared not only to appreciate what has been accomplished but also to plan the researches still required. All in all, the time seems ripe for a brief account of the past history, the present status and the future demands of our science.

Historical Development

The first beginnings of prehistoric archeology, though comparatively recent, are still veiled in obscurity. It must suffice to say that just as astronomy was preceded by astrology and chemistry by alchemy, so archeology was preceded by a similarly pseudo-scientific pursuit which we may call antiquarianism. The antiquarians and other hobbyists are still with us, probably always will be and certainly always have been, for we know from archeological sources that early man—in common with some of the lower animals—was endowed with the instinct for collecting rare and peculiar objects of all sorts. We are not surprised, therefore, to learn that a labeled display of relics was found in one of the rooms recently excavated in the palace at Ur, dating from about 3000 B.C. In addition, there are reasons for believing that fossils and other curios—probably stone implements—were kept in some of the Greek temples of the first millennium B.C. Historians vie in telling us of the somewhat later great museum at Alexandria, though no one seems to know what was in it besides manuscripts. We have read also of the royal curio collections kept at the various medieval European courts and which in modern times have given rise to some of the existing national museums. One might go on to cite contemporary descriptive and explanatory studies of such relics, were they not for the most part of questionable value in that they all fall within the range of endeavor that we have called antiquarianism, as distinguished from archeology proper. The essential difference in aim between the two pursuits lies in this, that while one values specimens chiefly for their own sake, as objects of art or as curios pure and simple, the other regards specimens primarily as means to an end, that end being the elucidation of culture history. Antiquarianism may fulfil a legitimate function, but its interests are sentimental rather than scientific, inspirational rather than informative.

The actual rise of prehistoric archeology should some day form an instructive chapter in the history of science. In the occidental world, up until the revival of interest in pagan learning in the fifteenth century, there was no room for even the concept "prehistoric." The world with all it contained was regarded as less than 6,000 years old and its entire history as somehow covered by written documents. These authoritative writings, including the Old Testament, Homer, Herodotus, Aristotle and others, had little to say about stone implements and nothing whatever about a Stone Age. On the other hand, even such enlightened pagan writers as Lucretius and Ovid, who speculated about the rise of man and culture, actually postulating a Stone Age, probably did not recognize *as such* the genuine stone implements that they may easily be supposed to have seen in public and private curio collections of their day. For stone implements were known to the Greeks and Romans, as well as to western Europeans of later times; but from before the beginning of our era down to as late as 1800 they were variously regarded as of superhuman and non-human origin. The oldest and longest-lived explanation was that they were thunderbolts, *i.e.*, objects formed in the air when the lightning flashed and as such endowed with magical properties, including the ability to protect against lightning. This old idea, as is well known, still prevails in many parts of the world. In later times recognized scholars also explained stone implements as natural products generated in the earth in the same way as fossils, as petrified iron implements, as symbols of the weapons wielded by the thunder god Thor, and finally as man-made implements used for ritual purposes, like the Jewish circumcision knife, which in Old Testament times continued to be made of flint.

Into the midst of this dark and scientifically hopeless world view a revealing ray of light had been suddenly thrown, following the year 1492, by the discovery of America and in the Pacific Islands of peoples who carried on for the most part with stone implements. But while this doubtless astounding phenomenon was

observed by Europeans from many walks of life and the news carried home, the acknowledged fact was explained for some time simply as due to cultural degeneration following as the natural result of mankind's dispersal from the Tower of Babel and so lost its significance for the stone implements found in Europe. A hundred years actually passed before Michael Mercati, physician to Pope Clement VIII, in 1593 ventured in the light of the new knowledge to write that the European objects called thunderbolts were implements of stone made and used by early man. In the course of the seventeenth and eighteenth centuries at least ten other writers vainly sought to convince the contemporary book-ridden scholars that Europe had once passed through a Stone Age like that observable in America. However, by 1836, when Director C. J. Thomsen, of the newly founded National Museum in Copenhagen, after twenty years' labor on the pre-Christian antiquities in his charge published anonymously a small pamphlet setting forth substantial evidence for the reality of the successive Stone, Bronze and Iron Ages in northwestern Europe, the whole western world was ready to accept and to apply his chronological scheme almost without comment or criticism. Thus the first step was gained for the conception "prehistory," though at the time the admission of a Stone Age for Europe meant little more than its earlier admission for America. Human existence was still regarded as limited to the estimated 6,000 years and the scattered stone-using peoples, ancient and modern, as no older than the earliest historic nations of the Near East. The former were merely unfortunate groups who had wandered away from the original high centers of culture and as a result lost the art of metallurgy and became users of stone. In the meantime, however, from 1750 onwards—and mostly since 1790—many discoveries had been made, especially in cave deposits and valley terrace gravels, of human skeletal and artifact remains associated with fossilized bones of extinct animals not mentioned in the historical records. The significance of this rapidly accumulating body of data finally became clear to a number of representative English scientists, including Sir Charles Lyell, Sir Joseph Prestwich and Sir John Evans, who accordingly in 1859 announced themselves as convinced beyond all doubt of the geologic antiquity of man. The battle with tradition being thus won at last, prehistoric research on all lines has since gone forward in Europe without hindrance, and scarcely a year has passed that has not witnessed new and important discoveries.

While this to us fantastic struggle between fact and tradition was slowly progressing in Europe, her colonizing citizens were rapidly becoming acquainted with the antiquities of other lands. The American continent was the first to come under scrutiny, and as the conspicuous archeological features here—ruins, earthworks, shellheaps, petroglyphs, etc.—were less ancient and therefore more easily linked with their originators than were the similar features of Europe, their consideration never involved comparable problems. For South America, if we ignore incidental references by early explorers and conquerors to abandoned palatial habitations and to the ancient practice of grave robbing, we have our first formal description of the famous Tiahuanaco ruin in Bolivia dating from 1554. Brief accounts of this and other Andean architectural remains followed from time to time during the next 250 years; but, though small relics were collected and described from about 1850 onwards, planned excavation for such remains is not definitely recorded until 1875. For Middle America we have to wait until 1785, when the equally famous Palenque ruins in Chiapas were first described. This revelation, together with the impetus given by Alexander von Humboldt, a German scientist who traveled in northwestern South America and Mexico from 1799 to 1804 and whose archeological observations were published in 1810, appears to have revived or set on foot a permanent interest in Latin American antiquities. At any rate, following that date, numerous elaborate surveys of ruins were made in Middle as well as in South America; but barring a few desultory attempts, especially by the French during their occupation of Mexico between the years of 1861 and 1867, no elaborate excavations for minor artifacts were undertaken until, as in South America, about the year 1875. From that time onward fieldwork involving excavation of some sort has been widely extended and of late much improved by the introduction of stratigraphic methods.

Coming to North America north of Mexico, and particularly the United States, the story of archeology is less spectacular, though scientifically more satisfactory. Observation, here as elsewhere, began with the conspicuous superficial features and only by slow degrees arrived at the systematic excavation and study of movable artifacts. Leaving out of account nearly all individual reports, however significant, ranging from those of the Norsemen in Greenland of the year 982 onward, the first sign of general interest in our antiquities was a prolonged discussion, beginning about 1680, bearing on the New England petroglyphs, such as those on Dighton Rock in Massachusetts. The second flare-up of popular interest came about the year 1780, or immediately after the Revolutionary War, when General Rufus Putnam and other military officers took up land in the Ohio Territory and at once began to send descriptive accounts of the mysterious earthworks of that region. This interest in the Mound-builder remains died down at least twice, though it is

now again probably more alive than ever before. The third and last preliminary phase dates from 1849, when Lieutenant J. H. Simpson turned in the first detailed report on certain of the large ruins in the Southwest. This equally exciting though less mysterious discovery also suffered brief periods of neglect, but the field is at present receiving more scientific and popular attention than any other. The fourth or present phase, dating from about 1870, marks the beginning of shellmound investigations in California, in the Aleutian Islands, in Florida and elsewhere—a type of work which for results required much digging. Since that time, *i.e.*, since 1870, excavation methods—recorded from time to time as far back as 1784 when Thomas Jefferson employed them on a Virginia mound—have been applied in gradually improved form in all the indicated major fields. Also the investigation, here as in Latin America, has been geographically extended and to-day includes the outer borders of Canada, as well as Alaska, Greenland and the West Indies.

The particular aspect of American archeology concerned with the geologic antiquity of man deserves special mention. Until recently the inquiry has been handled mostly by geologists and paleontologists with results far from satisfactory. The topic was suggested in concrete form as early as 1772, when Peter Kalm published his notes on certain long previously reported finds of artifacts in the Quaternary deposits of New Jersey. It was broached again in 1835 by P. W. Lund's discoveries in several Brazilian caves of a considerable amount of human skeletal material apparently associated with bones of extinct animals of Pleistocene age. Neither contribution appears to have stirred up any comment at the time, however, and the subject did not become really alive until after 1850, when the occurrence of cultural and skeletal material, including the famous Calaveras skull, began to be reported from the Tertiary gold-bearing gravels of California. These alleged discoveries were reviewed between the years 1866 and 1879 by the geologist J. D. Whitney, who in 1880 published his report accepting the evidence as proving man's existence in America perhaps as early as Miocene times. During the same period, or between the years 1861 and 1867, French scientists contributed a number of suggestive finds from Mexico, which, though briefly reported by E. G. Tarayre in 1884, appear never to have been discussed. More successful in gaining notice were the numerous startling discoveries, beginning in 1870, by Florentino Ameghino in the Pampean and earlier formations of Argentina, on the basis of which man's, or rather proto-man's, antiquity was traced back to Eocene times! Almost simultaneously with these extravagant claims, *i.e.*, in 1872, Dr. C. C. Abbott began to report the occurrence of supposed stone implements of Paleolithic type in the Quaternary gravels of Trenton, New Jersey. Other widely scattered finds of lesser import have been reported from time to time before and since, until to-day there are at least two hundred of them recorded in the literature. But in the meantime the lively discussion, started about 1870, died down by 1890 and was not revived again in full force until 1916, with new and better authenticated discoveries, this time in Florida. Since 1927 the centers of interest have been transferred to Ecuador and to the Rocky Mountain states, archeologists have joined in the search, and the investigation is now at last placed on a thoroughly sound footing, with results that are more nearly in keeping with what is known from the rest of the world.

The remainder of the habitable world, in spite of its size, need not detain us long because prehistoric studies are here of relatively recent date. Europeans were comparatively slow to invade both Asia and Africa, though in one way or another they had known something about these realms since long before America was discovered. But even after their arrival they found in those continents only a few conspicuous monumental remains such as had excited attention in Europe and America. Nevertheless, referring to Africa, surface collecting can be traced back to 1857 in Cape Colony, to 1866 in Egypt, to about 1885 in Algeria and the northwest, to 1893 in East Africa and to about the same date in the Congo region. However, the first planned excavations appear to date back only to about the beginning of the present century and to have been at first confined mainly to Egypt and the French northwest. Adequate stratigraphic work is an achievement of the last ten years and at present is receiving special though not exclusive attention in Egypt and East Africa.

Archeological developments in Asia, if we omit reference to historic or classical studies, cover about the same length of time; but progress here has been more slow and steady than in Africa. Of preliminary surface collecting little is known except for early paleoliths first reported in India in 1863 and for neoliths first brought from Yunnan in 1870. But already during the decade 1860 to 1870 Wilhelm Radloff had made random excavations in Neolithic Bronze and Iron Age sites in western Siberia. This was followed in 1879 by E. S. Morse's introduction of shellmound excavation in Japan and by the beginning of French excavations in the Caucasus region, Upper Paleolithic discoveries in Siberia in 1884 and by Eolithic discoveries in Burma in 1894. With the turn of the century, in 1902, excavations began in the Neolithic and possibly Paleolithic caves and shellheaps of French Indo-China and also in a large part

Neolithic mound at Susa in Mesopotamia. The latter type of work was duplicated in 1904 in two large Neolithic and Metal age mounds at Anau in Russian Turkestan. Finally, in 1905, several caves thought to exhibit Upper Paleolithic remains were tried out in the island of Ceylon. There followed apparently a brief lull in most places, incidental perhaps to the Great War, but since then activities have picked up again and are going forward on a grand scale in various sections of northern, middle and southern Asia. Incidentally, the work here as everywhere else was initiated by occidentals but is now taken part in if not, as in Japan, conducted entirely by native-born investigators.

When we turn finally to the great island world occupying the Pacific and Indian oceans our story is still more brief. Conquest and settlement of the Philippine and East Indian portions date from the sixteenth century, but Australia and the rest were not occupied until 1788 and later. Leaving the *Pithecanthropus erectus* find in Java out of account as perhaps a missing link not yet provided with implements, little archeological information has been available about this vast region until the present century. Early knowledge was limited, on the one hand, to a number of more or less remarkable ruins and monumental remains scattered through the East Indies, Melanesia, Micronesia and parts of Polynesia, and, on the other hand, to a few surface pickings of stone implements chiefly from Australia, Tasmania, New Zealand and Hawaii. Since 1903, however, minor excavations have been made in Celebes, the Philippines, Formosa and perhaps farther east; but the only really stratigraphic excavations have been carried out in Java and Australia respectively within the last ten and six years.

Present Status

After all these mostly dry historical details it will be a relief to consider briefly what prehistoric archeology has actually accomplished during its short period of activity. From what has been said it should be apparent that most of the habitable world has been at least superficially explored and that to-day we have a fairly clear idea of the archeological possibilities of even the most inhospitable regions. Thus, omitting the little known interiors of Borneo and New Guinea, we have for all the rest of the world, including tropical jungles and arctic tundras, at least some descriptive information about conspicuous architectural and other fixed antiquities. The less forbidding localities, like the great deserts, have yielded in addition large collections of surface-gathered artifacts. Regions nearer the present centers of civilized life, particularly those of the temperate zones, have been subjected besides to more or less extensive random excavation for the purpose primarily of obtaining small relics. Lastly, in not a few places and naturally those favored for long periods by early man, systematized excavations, embodying stratigraphic methods where possible, are also well under way. This intensification of fieldwork, ranging geographically from the less favored towards the more favored regions of the world, is reflected also by the time order of research developments in the several main centers of archeological activity. That is to say, the general order of inquiry has everywhere been about as follows: first, discovery and description of monumental remains, as in our mound area; second, surface collecting and typological studies of movable remains, resulting sometimes, as in Africa, in the identification of culture centers; third, random excavation for small relics with the same end in view and including perhaps the approximate bounding, as in America, of culture areas; and, fourth, stratigraphic excavation, making possible a determination of the time order, if not also the technological evolution of the industrial stages within the given culture areas, as achieved for example in our own Southwest. Both of these general modes of progress have been more or less inevitable, not only because it was natural to begin with the conspicuous monumental remains but partly also because monumental remains often defy interpretation as to date and purpose except in terms of the small implemental objects that accompany them. For instance, in order to discover the function, say, of an earthmound, excavation may be necessary to learn that it was used for burial purposes. Again, to discover the relative date of the mound with its known skeletal and cultural contents it may next be necessary to excavate a local stratified culture deposit, such as a refuse heap, to obtain the time position of the implemental trait combination as found in the mound. In other words, because the evolution of stone implements or of pottery is longer, more uniformly varied and therefore more easily understood with respect to the all-important element of time order, chronological determinations for all other associated culture traits are most easily worked out through the employment of these better known media.

Turning to the different areas of the world field, present achievements may be briefly summarized. In the case of western Europe all known monumental features, including cave art, have been described, immense collections have been accumulated, typological studies have long been in progress and stratigraphic investigations are in an advanced state, as is indicated by chronologically arranged museum exhibits. The stratigraphic method has been applied wherever possible: to artifact inclusions in geologic formations, to artificial cave debris, to shellheaps, to pile-dweller deposits and to superposed ruins. In some countries,

like Denmark, the available chronological outlay from the Iron Age back through the Bronze Age, the Neolithic period, and into the final phase of the Mesolithic period appears to be completely set in order; while elsewhere, as in France, the preceding Paleolithic succession is gradually being pieced together and extended until it seems as if the whole story of cultural evolution is complete at least as far as time order is concerned. All these cultural stages and sub-stages have been tentatively correlated with the whole range of oscillating climatic changes characterizing the Quaternary geologic period, now estimated to have endured for about a million years; and those who champion eoliths have taken cultural beginnings back several million more years, through Pliocene and into Miocene times. Incidentally, in Sweden an absolute chronology has been worked out for post-glacial time by the counting of annual silt deposits. Also incidentally, at least some light has been thrown on the general succession of racial types in Europe. These accomplishments have all been made intelligible to the interested public through museum exhibits and through a series of semi-popular handbooks such as are available for no other part of the world.

In America the archeological field has been cultivated, if perhaps less intensively, at least as long and as extensively as in Europe. As evidence of this we have long possessed elaborate descriptions of ruins, mounds and petroglyphs; we have several more recent studies of mines, quarries, workshops, cave habitations and village sites, including shellheaps; and our very large semi-scientific collections have received typological treatment in both formal reports and semi-popular handbooks. Lastly, our stratigraphic investigations, begun in earnest about thirty years ago, have now been applied to both natural and artificial deposits and are well under way, for example, in the Southwest, in California, Florida, New York and Nebraska, in Mexico valley, in Andean South America and even of late in Alaska and Tierra del Fuego. One important result of all this labor is that man and culture in America can now safely be carried back some as yet uncertain distance into post-glacial time. Another is that we perceive here an independently developed segment of cultural evolution embracing what in Old World terms might be called the Late Paleolithic, Neolithic, Copper and Bronze Ages.

In Africa, except for bare descriptions of Mediterranean shore dolmens and a little excavation in some late Rhodesian ruins like those of Zimbabwe, archeological investigation has until lately been confined to Stone Age remains. These remains include shellheaps, cave-wall art and small artifacts. Of the last large surface collections have been made and independent preliminary typological studies of these have resulted in a confusing lot of names for localized and slightly differentiated culture complexes, seemingly in need of correlation and simplification. But assistance is now apparently on the way, for during the last few years much stratigraphic work of one kind or another has been carried out, especially in the Nile valley gravel terraces and in various types of natural and artificial deposits in Kenya Colony. In the latter region it is claimed, incidentally, that human existence, as judged by both cultural and skeleton discoveries, can be traced back, as in Europe, to the beginnings of Pleistocene if not to Tertiary times. Speaking generally, Africa seems to be strong on Lower Paleolithic flint industries, weak, except in the northwest, on typical Upper Paleolithic material and only moderately strong on Neolithic material. Some indications of early work in copper and other natural metals appear to be present, but the Bronze technique is absent. In other words, the Iron Age followed directly on the Stone Age.

Asia, like Africa, has furnished at least some descriptions of fixed remains such as mounds, megalithic monuments and cave-wall art. Partly described surface collections ranging from the Lower Paleolithic upwards are also available from various localities, especially Mongolia; but most of our published information has until recently been derived from random excavations in sites representative of the Middle and Upper Paleolithic as well as of the Neolithic, Bronze and Iron Ages, with the Bronze Age apparently omitted in some places here as in Africa. Now, however, within the past ten years large collections have been delivered to us in orderly fashion from two of the thickest stratified deposits yet found anywhere in the world and which have yielded an abundance of both cultural and skeletal remains. One, a cave deposit in Palestine, measured over 70 feet in depth, and its cultural contents take us from historic times well back into the Lower Paleolithic stage. The other is a cave deposit near Peiping, China, which, judged by accompanying faunal remains, is regarded as dating back at least to the Middle Pleistocene. In addition, a culture stratum of similar age has been found elsewhere in North China in a geologic deposit no less than 180 feet below the soil surface. In view of all this, Asia's traditional claims to being the birthplace of man are much strengthened, a fact which has a direct bearing on our own problem of the antiquity of man in America.

Oceania must be dismissed with a mere glance. As already indicated, we have descriptions from certain northerly sections of this vast area of both ruins and monuments, as well as of surface collections of stone implements that by courtesy may be called archeological; but it is only the larger southern and western islands nearest the Asiatic mainland that in addition

have yielded clear indications of prolonged habitation. In Australia, for example, these as yet undated evidences are reported in the form of cave-wall art, shell-heaps of some size, seemingly primitive human cranial material and excavated rock-shelter culture deposits reaching as much as twenty feet in thickness. Thus far, however, it is the island of Java alone that has furnished both primitive skeletal remains and Lower Paleolithic stone implements of undoubted Pleistocene age.

The conclusions to be derived from this brief and superficial world survey must necessarily be very general. In view of the emphasis constantly placed upon *antiquity* and *cultural characteristics*, it is in order to suggest first of all that the evidence thus far recovered tends to confirm the long-prevailing view that man originated in the Old World in pre-Pleistocene times, that he reached the New World only after the last glacial retreat, when he was still a roaming hunter but in possession of a fully developed flintworking technique, and that he arrived in the eastern Pacific and other outlying archipelagoes relatively late, in fact in what for the continental regions were largely post-Neolithic times. Another safe conclusion is that our chronologically ordered discoveries have given us a fairly complete account of the evolution of the world's stoneworking processes, ranging from crude to highly skilled percussion flaking, through pressure chipping to pecking, grinding and polishing, thus giving us a clue not only to the technological but also to the relative time position of any given culture complex containing stone objects. We have learned also that the Three-Period system of Europe, embracing the Stone, Bronze and Iron Age sequence, does not apply uniformly to all places, especially in Africa and Asia. Last of all, in view of what is now known about the progress of material culture as a whole, it seems certain that the important economic shift from the original nomadic hunting or food-gathering existence to our present settled mode of life based chiefly upon agriculture took place first about midway in the great desert zone stretching from Morocco to Mongolia and that it was the result probably in part of the gradual desiccation and consequent food scarcity which followed the last glacial retreat. Just when this change, giving rise to division of labor and so by relatively swift steps to modern civilization, began is still uncertain, but present estimates vary all the way from 5500 to 18000 B.C.; and the truth doubtless lies somewhere between the two extremes.

FUTURE REQUIREMENTS

There remains to suggest briefly what prehistoric archeology has still to achieve in the field, in the museum and in the study. With so much actually accomplished what precisely is now lacking? The answers are many and varied. Thus far, naturally enough, the investigation has been mainly one of fact-finding, but even in this department there are important gaps in our knowledge and therefore doubtless serious defects in our interpretations. For instance, we do not yet know *when* or how far back in geologic time man and culture originated, whether in the Pliocene or the Miocene. Stated in another way, we need more light, for example, on the Eolithic problem; and this, indirectly, might well come from the New World, *i.e.*, from studies of flaked pebbles in corresponding Tertiary deposits, here supposedly long antedating the coming of man. We are equally ignorant as to *where* the decisive step first took place. Europe, Asia and Africa all present their special claims. Until these problems are settled we can not definitely say *how* or in what time order our two connected phenomena spread over the world, and in particular when or in what culture stage man first reached the American continent. Unanswered also are such secondary questions as to what became of the Neanderthal race and, more important still, from where did Cromagnon man or *Homo sapiens* suddenly arrive in western Europe? The field, in other words, obviously requires further investigation. We are in need, for example, of collections from many little-known areas such as the jungle, tundra and desert regions in various parts of the world. Collections are especially required from such strategic localities as northeastern Siberia, Alaska, the western plains of Canada, our own Great Basin and northern Mexico, to name only those nearest home. And, most important of all, we need stratigraphic work done in all but a few of our recognized culture areas throughout the world in order to establish first the relative and next the absolute chronologies that shall enable us finally to plot the place of origin and early movements of man and culture in visible form on the geologic column.

The archeological museum requires work in several different departments, such as the laboratory, the storerooms and the exhibition halls. In the laboratory, besides the improvement of normal routine, more study and experimental work are needed, for example, on the art of percussion flaking and pressure chipping in order that we may come to a fuller understanding of the varying degrees of expertness involved and so be better able to estimate the technological status of our individual specimens. In our storerooms, it is safe to say, is to be found a great deal of neglected work, in fact, neglected opportunities. Museums have hitherto been so exclusively intent upon exhibition facilities that they have given little thought to the adequate housing of study collections. As a result curators come and go at the larger museums, while immense

accumulations of costly specimens sometimes remain unnoticed. Probably much the same condition obtains with respect to most of the smaller collections, both public and private. The opportunity to enter the open field, even if previously investigated, is generally more inviting than the dusty attic. Nevertheless, it can hardly be denied that our fieldwork could be done more intelligently and more economically if we had our storage collections classified and arranged geographically, chronologically and typologically. More than that, it is only by complete familiarity, especially with our chipped stone material, that we are ever likely to become able to separate our intentionally designed implements from the merely accidental forms or to develop a really satisfactory classificational terminology. Stated in another way, the real advancement of our science depends much more upon what we do with our storage than upon what we do with our exhibits. However, in the museum proper we are actually confronted with a variety of more and more pressing problems. Hitherto we have offered the public for the most part only miscellaneous mass displays, astonishing enough perhaps as collections of meaningless curiosities but of little educational value. These exhibits, as our collections increase, must necessarily be condensed and simplified. Towards this end we should present chronological displays wherever possible, with typological subdivisions showing the order of appearance and general course of evolution of all the different arts and industries. For the culture areas lacking chronological determinations we might at least substitute synoptic exhibits with similar subdivisions for the various activities represented. Instructive also would be typological displays showing the complete geographic range of all the different inventions. Finally, we need to develop technological exhibits showing the normal order of gradual improvement of early man's skill in dealing with the various raw materials, such as stone, shell, bone, wood and fiber, skin, clay and the natural metals. In this connection the utilization of fire in the industrial processes, such as those of ceramics and metallurgy, would seem to need special emphasis, because it was this application alone that made modern industrial civilization possible.

We have finally to consider the study and the library. The requirements here also are twofold: those pertaining to the progress of the science of archeology itself and those pertaining to the education of the public. For the use of professional students, particularly in the United States and Canada, we need a complete bibliography, regional and subject, so that when any man or institution wishes to undertake a regional study or a piece of work in a given culture area it may be possible quickly to learn what has already been done in that particular field. Also we need an all-round good text-book on prehistoric archeology, an undertaking now almost beyond the capacity of any single scholar because before he can finish the last of his surveys the first is likely to be out of date. For more general use we need a new handbook in English for the American continent, somewhat like those long available for Europe. More especially we need a handbook for the United States and Canada, such as was begun by W. H. Holmes and the second and most important part of which lies perhaps partly finished. We need also for America, or at least for North America north of Mexico, an album illustrating all the principal forms of our antiquities. Such an album, with brief textual legends giving both time and space distribution for all incorporated inventions, might be patterned after that published for Europe by G. de Mortillet as long ago as 1881; but probably it would be more serviceable if its contents were arranged by industries, such as flaked and chipped stone, shellwork, bonework, woodwork, skinwork, basketry, textiles, ceramics and metallurgy. Additional topics might be included, as called for, relating to such skilled activities as hunting and fishing, agriculture and animal husbandry, medicine and surgery, quarrying and mining, architecture and engineering, decorative and pictorial arts, religious symbolism, and so on. The different sections might very well be issued separately to meet the varying demands which now exist. Such separates, provided with suitable general introductions, might even serve as popular guide leaflets to all the various basic arts and industries originated and developed by prehistoric man.

Summary and Conclusion

The attempt has been made in the foregoing paragraphs to outline the whole history of prehistoric archeology: its crude beginnings in ancient times, its steadily accelerating progress during the past two hundred years, and its present achievements. Special emphasis has been placed on the rôle played by the discovery of surviving primitive industries in America and elsewhere in bringing about a rational attitude towards Stone Age antiquities and a beginning of their systematic investigation. The creation and growth of the organization and personnel promoting and conducting this world-wide research must be left untouched except to say that to-day probably every civilized country has its museums and university teaching staffs. Public interest in man's prehistoric past was never greater than to-day and only financial support is necessary to afford opportunity for the increasing numbers of young men and women who are constantly pleading for a chance to take part in the work. Accordingly, though the task before us is still very great it is not so hopeless as in the case of some other

purely natural sciences like astronomy and entomology. For not only is the earth spherical and therefore limited in extent but man's period of occupancy is relatively short. In other words, while prehistoric archeology of necessity was one of the last special branches of research to get really under way, it is likely to be the first to finish its task. Indeed, if archeological investigations, historic and prehistoric, continue to progress at the same accelerating rate as in the past, it would seem that the next hundred years or so might easily see us in possession of all the essential facts. Those more or less indestructible facts or documents once in hand and the spade set aside, archeologists may have to change their titles to those of curators or something even less high-sounding. At all events, those professionally concerned may then devote their entire time to the permanent arrangement and final interpretation of all the available material culture traits, with a view to offering a visible demonstration of how, step by step from small beginnings, things as they are in the human world actually came to be so. That accomplished, when every one has become familiar with our recreated past, we shall be more nearly free and in the best possible position to give our whole-hearted attention to the really major creative problems of the present and the future.

HOW BREATHING BEGINS AT BIRTH[1]

By Professor YANDELL HENDERSON
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ONE of the oldest problems of science is: Why does the baby begin to breathe at birth? The purpose is clear; but the cause and means are obscure.

Half an answer has long been available. It is well established that for many weeks or even months before birth the fetus makes distinct rhythmic respiratory movements. Ahlfeld[2] in 1915 published excellent graphic records of these movements. They were taken from the surface of the mother's abdomen. And a number of recent investigators have obtained moving pictures of respiratory movements in animal fetuses delivered by Cesarean section in a bath of warm saline.[3] But these movements are ineffective in expanding the lungs and keeping them expanded. The question then becomes: How are the feeble and ineffective respiratory movements of the fetus transformed into the effective breathing of the newborn?

The answer, I believe, is to be found in the fact that a certain function is deficient in the fetus; and that this function is quickly developed at birth and is then continually maintained throughout life. It is a function of critical importance alike for respiration, circulation and metabolism: the function of muscle tonus.

Many years ago I found that, when a man or animal dies, the muscles lose their tonus within five or ten minutes.[4] I was investigating various forms of manual artificial respiration. What I found was that only so long as tonus continues do the thoracic muscles and diaphragm retain a sufficient degree of elasticity to keep the lungs well expanded. And only so long as the lungs are thus held to a fair degree of expansion is manual artificial respiration effective. Pressure upon the chest, abdomen or back squeezes air out of the lungs. The inspirations that occur between compressions are produced wholly by the tonic elasticity of the victim's own muscles that pull the chest back to mid-expansion. After the body is entirely flaccid no form of manipulation can induce the slightest inspiration. When tonus is lost, the cubic capacity of the chest decreases and the lungs are correspondingly deflated. Even if the lungs are then inflated with a bellows, they deflate again as soon as the inflation is ended.[5] In normal breathing a large volume of air is held in the lungs even during expiration: the so-called stationary air.

The maintenance of a considerable volume of stationary air is extremely important. Unless the lungs are continually held in a sufficient degree of inflation, adequate aeration of the blood, either by artificial or by natural respiration, is impossible. Hess[6] has shown that even the movements of normal breathing may be regarded as essentially due to rhythmic variations in the degree of tonus in the respiratory muscles and particularly in the diaphragm. Extending this idea we may consider that the extent of the inflation

[1] Read before Connecticut Academy of Arts and Sciences, New Haven, Conn., December 10, 1936.

[2] F. Ahlfeld, *Monatsschr. f. Geburtsh. u. Gynäk.*, 21: 213, 1915.

[3] J. Barcroft, "The Brain in Its Environment," Yale University Press (in press).

[4] Y. Henderson, *Jour. Amer. Med. Assoc.*, Vol. 67: 1, 1916.

[5] The fact that no form of manual artificial respiration can directly induce an appreciable degree of inspiration affords no valid reason for the use of apparatus for artificial respiration. So long as tonus is present, manual methods are effective. When tonus disappears, the victim is dead beyond recall. Such apparatus as the pulmotor and others that apply suction to the lungs, promote, not recovery, but a further deflation of the lungs. For resuscitation in cases of atonic asphyxia of the newborn (*asphyxia pallida*) intratracheal insufflation is much more effective than any form of artificial respiration.

[6] W. R. Hess, "Die Regulierung der Atmung," Leipzig, 1931.

at which the lungs are normally held is a function of the tonus normally maintained in the respiratory muscles. The posture of the head and body in sitting or standing is well known to be dependent upon the maintenance of tonus in the muscles of the neck, back and legs. Similarly, the degree of inflation of the lungs that is maintained throughout life may be regarded as a posture dependent upon the tonus of the respiratory muscles. From birth to death the lungs are never deflated, because the diaphragm is never completely relaxed. For the development of effective pulmonary respiration at birth, tonus is essential.

The beginning of effective breathing may be aptly compared to the starting of an automobile. When the car is standing still, but with its engine running gently, we speak of its motor as "idling." And so it is with respiration before birth. The analogy may be carried even further. The baby that is born in asphyxia resembles a motor that is stalled. And as with the motor, so with the baby, a restoration of activity may be induced in two ways. The motor may be cranked and spun until, in spite of poor carburetion and ignition, a "cough" is induced. The baby likewise may be manhandled, as it formerly commonly was, until a reflex gasp is elicited. Or, on the contrary, in the car the carburetor and ignition may be adjusted until the motor starts at a touch. And in the baby the oxygen and carbon dioxide that its nervous system needs may be supplied by inhalation, as has now become the accepted practice; and resuscitation is thus effected without "cranking."

In such resuscitation it is not merely respiration that is involved.

Recently Oughterson, Greenberg, Searle and I[7] have produced evidence that muscle tonus normally plays a no less important and necessary part in the circulation of the blood. The slight pull that tonus maintains in all muscles even during relaxation induces a pressure between the muscle fibers like that produced between the strands of a rope under tension. This pressure prevents the blood from stagnating in the capillaries and promotes its flow into the veins and onward back to the heart. In the venous return muscle tonus plays an essential part. In the maintenance of the circulation the venopressor mechanism is second in importance only to the heart itself; for without the venous return the heart can not operate. The control of the venous return is exercised largely through muscle tonus by the motor centers in the spinal cord. It is distinct from the control of arterial pressure and the distribution of the arterial blood by the vasomotor, or sympathetic, nervous system. Cannon[8] has shown that, even after complete removal of the entire chain of sympathetic ganglia, animals (cats) may live in a fair degree of vigor. But, as I found 30 years ago,[9] when the venous return fails, the circulation stops; and as we have recently shown muscle tonus is an essential support for the venous return.

At birth the circulation undergoes a fundamental change. As the placental vessels contract, the blood is sent in full volume through the lungs. Previously the flow of blood back and forth between the fetus and the placenta has needed no support by muscle tonus. But at birth the circulation takes on a new vigor. The left side of the heart comes into action and arterial pressure rises to a higher level. For this adjustment a full venous return, induced and maintained by muscle tonus and intratissue pressure, is essential. This is shown by the fact that whenever, because of asphyxia during birth, tonus fails to develop, the flaccid baby exhibits the infantile form of shock, *asphyxia pallida*.

Before birth the fetus, floating in a fluid at body temperature, need produce little heat of its own. After birth the baby must assume the maintenance of its own heat supply to compensate for a continual loss of heat to a generally colder world. Normally the requirements of body temperature are soon met by the establishment of a basal metabolism sufficient to meet this requirement. And in the control of metabolism tonus plays a major part. The tonic pull of the muscles involves a consumption of oxygen, production of carbon dioxide and liberation of heat. And all these related functions are thus influenced by the nervous impulses from the motor centers in the spinal cord that chiefly induce tonus.

In respect then to the three vitally important functions of respiration, circulation and metabolism, the fetus has little need for tonus. But, if the baby is to establish and maintain its independent life, tonus is essential. In fact, the difference between the vigorous child and one that barely lives even in an incubator—the case of "Lebenschwäche" as the Germans term it—probably consists chiefly in the degree of their tonus. Even in the normal baby the lungs are dilated only gradually during the first day or two after birth. In the premature with a subnormal tonus the lungs may remain partially unexpanded for weeks. Along with the continuance of atelectasis the circulation is weak, metabolism and oxygen consumption low and heat production inadequate. Correspondingly the production of carbon dioxide is inadequate to produce full breathing; cyanosis develops; respiration is further depressed, and asphyxia ensues. Experience is showing that the most effective way to break this "vicious

[7] Y. Henderson, A. W. Oughterson, L. A. Greenberg and C. P. Searle, *Amer. Jour. Physiol.*, 114: 261, 1936.

[8] W. B. Cannon, *Amer. Jour. Physiol.*, 89: 84, 1929. Also "The Wisdom of the Body," New York, 1932.

[9] Y. Henderson, *Brit. Med. Jour.*, 2: 1872, 1906; and Y. Henderson and S. C. Harvey, *Amer. Jour. Physiol.*, 46: 533, 1918.

circle" is to stimulate an increase of tonus and deeper respiration by inhalation of carbon dioxide. Deeper respiration is the most effective means of inducing a better oxygenation of the blood; it is far more effective than inhalation of pure oxygen without deeper breathing. In the mixtures of oxygen and carbon dioxide now commonly used the carbon dioxide is the effective agent and the oxygen only a slightly better diluent than mere air.[10] A decisive demonstration of the life-saving value of the inhalational treatment of premature infants was afforded by Dr. A. R. Dafoe's success with the Dionne quintuplets.

But is it true that muscle tonus is practically absent in the fetus and develops at birth? The answer is afforded by observations made by D. H. Barron in Professor Barcroft's laboratory and reported by the latter[11] without, however, the full interpretation which I have here assigned to tonus.

The observations of Barcroft and his collaborators have been made chiefly upon sheep at various stages of gestation. The fetal lambs are delivered by Cesarean section and the placental circulation is maintained while the mother's body is immersed in a bath of warm saline. Under these conditions, as Barcroft reports, Barron has recorded the tonus of fetal lambs by means of the method described by Adrian for recording the electrical state of the muscles. "So long as the fetus is in its normal environment, or in a bath of warm saline, with the placental circulation unrestricted, the fetal muscles are entirely devoid of tonus. Take the fetus out of the saline and expose its skin to the air; tone at once appears in its muscles, only again to be abolished by replacing the embryo in the bath."

What tonus means for the beginning of life can be verified by noting the crucial part that this little noticed but fundamental function often plays in the end of life. The condition of physical depression that may follow serious physical injuries and major surgical operations—the state that in its extreme form is termed shock—has long been explained as due to fatigue, paralysis or some other form of failure of the control by the sympathetic nervous system over the vasomotor mechanism. A few investigators, including the writer, have refused to accept this conception; but until recently we failed to offer a wholly satisfactory alternative conception.

Now it is becoming clear that the depression lies, not in the sympathetic nervous system, but in the motor centers of the spinal cord; and that it results in such a depression of muscle tonus that respiratory metabolism and heat production are diminished, the blood stagnates in the tissues, the venous return to the heart fails, and the respiratory muscles relax until parts of the lungs are deflated.[12] Decisive experimental evidence for this conception of postoperative depression and shock is afforded by the fact that a condition in all respects like shock can be induced temporarily by spinal anesthesia. This occurs whenever the anesthetic reaches, not merely the sensory neurones for which it is intended, but the motor neurones that induce muscle tonus.[13]

To summarize: At birth the motor centers of the spinal cord come into action. By inducing tonus in the musculature of the body they increase metabolism and heat production, and render respiration effective. Without muscle tonus the blood would stagnate in the tissues and the circulation would fail. During life a high tonus is a feature of vigorous health. It is such tonus that enables the young soldier to stand long at attention. The elderly man of lessened tonus can not stand long without fatigue. The invalid may have sufficient tonus to permit him to sit, but not to stand. The patient with a low tonus and weak after operation or illness can scarcely hold his head up from the pillow. And, as death approaches, it is the failure of tonus that permits the major functions of respiration, circulation and metabolism to fail.

[10] Y. Henderson, SCIENCE, 83: 399, 1936.

[11] J. Barcroft, *Setchanov. Jour. Physiol.*, 4: 35, 1935; *Physiol. Rev.*, 16: 103, 1936; J. Barcroft and D. H. Barron, *Jour. Physiol*, 88: 56, 1936.

[12] Y. Henderson, *Bull. N. Y. Acad. Med.*, 11: 639, 1935; *Lancet*, July 27, 1935, p. 178.

[13] O. O. Schuberth, *Acta Chir. Scand.*, 78: Suppl. 43, 1936.

OBITUARY

MARSHALL AVERY HOWE

DR. MARSHALL AVERY HOWE, director of the New York Botanical Garden, died at his home in Pleasantville, New York, on December 24, 1936, in his seventieth year. Scion of an old Vermont family, he was born at Newfane, in the southern part of that state on June 6, 1867. In 1891, the year following his graduation from the University of Vermont, he went to the University of California as instructor of cryptogamic botany; there he remained for five years, devoting himself particularly to studies on hepatics and marine algae, the plant-groups which continued to hold his interest for the remainder of his life, although the algae received more of his attention than the hepatics in later years.

In 1896 he enrolled for graduate study at Columbia University, where he was a fellow in 1897–98, received the Ph.D. degree in the latter year, and remained as curator of the herbarium until 1901. At Columbia he was closely associated with those who

were engaged in the early development of the New York Botanical Garden, but it was not until the summer of 1901 that he was appointed to a position on the Garden staff, and relinquished his curatorship at the university. During that summer, accompanied by his brother, Clifton D. Howe, and another assistant, he spent some time in the botanical exploration of Nova Scotia and Newfoundland; collecting trips for marine algae in subsequent seasons took him to Florida, various parts of the West Indies and Panama.

He became assistant director of the New York Botanical Garden in 1923, and so continued until 1935. His directorship was from October 1, 1935, until his death less than fifteen months later; ill health for much of this period interfered with his duties in this office, yet his appointment as director was a fitting climax to his thirty-five years of faithful service in building up this great institution. In spite of his failing health the end came suddenly and unexpectedly.

He was a member of various scientific societies. Perhaps the earliest was the Chamisso Botanical Club, organized at the University of California early in 1891, a few months before his arrival there; of this society he was the third president. In the summer of 1895, while on a vacation in his home state, he was one of the six botanists who planned the Vermont Botanical Club, of which he became an original member when organization was effected. On January 12, 1897, soon after his arrival in New York, he was elected to active membership in the Torrey Botanical Club; the following year he was chosen an associate editor and was reelected annually thereafter, with the exception of the years 1908–10, when he was editor-in-chief of the *Bulletin* and *Memoirs* of the club. When the Torrey Club in 1901 added a smaller monthly, called *Torreya,* to its other publications, he was chosen editor of the new journal and so continued for seven years. At other times he was secretary and vice-president and he had been president for nearly a year at the time of his death.

In 1897, too, he became a member of the New York Academy of Sciences, and was soon thereafter elected a fellow of the academy. He was almost or quite continuously a member of the council from 1914, and was president in 1934 and 1935. His membership in the Botanical Society of America dated from 1899, and he was vice-president in 1913. The ballots for office in this society are cast by mail, and it was announced at the meeting a few weeks ago in Atlantic City that he had been duly elected president for the year 1937. This final honor, alas, came too late.

He was elected to membership in the American Association for the Advancement of Science in 1900, and became a fellow of the association in 1903. In 1907 he joined the Sullivant Moss Society, in 1911 the American Fern Society, in 1914 the American Society of Naturalists and within the few following years the Connecticut Botanical Society. In 1919 his alma mater, the University of Vermont, conferred upon him the honorary degree of Sc.D. And in 1923 he was chosen as a member of the National Academy of Sciences, an honor highly esteemed by most American scientists.

As a worker and as a writer he was extremely painstaking and conscientious. His contributions to botanical literature were numerous, and a few of them were sufficiently bulky to be regarded as books, although they all formed parts of serial publications. The earlier ones related chiefly to hepatics, the later ones to marine algae, but his interest in both groups was continuous throughout his career.

This brief outline of the life of Marshall Avery Howe furnishes unequivocal evidence of the high esteem of his fellow-workers. Those who knew him best respected him most, and his passing leaves his associates with a sense of profound loss.

J. H. BARNHART

RECENT DEATHS AND MEMORIALS

CYRUS R. CROSBY, professor of entomology at Cornell University, died on January 11 on his arrival in Rochester for the annual meeting of the New York State Horticultural Society. He was fifty-eight years old.

DR. ELIAS HUDSON BARTLEY, professor of chemistry and pediatrics at Long Island College Hospital until his retirement with the title emeritus in 1931, died on January 12. He was eighty-seven years old.

DR. MICHAEL H. CORRIGAN, president of the Rhode Island College of Pharmacy and Allied Sciences, died on January 16 at the age of sixty-eight years.

DR. CHARLES V. NOBACK, since 1926 veterinarian at the New York Zoological Park, died on January 16 at the age of forty-eight years.

DR. WILLIAM HENRY COLLINS, consultant to the branch of mines and geology of the Department of Mines and Resources of Canada and acting director of the National Museum, formerly director of the Canadian Geological Survey, died on January 14 at the age of fifty-eight years.

PROFESSOR ROBIN TILLYARD, an honorary fellow of Queen's College, Cambridge, chief entomologist of the Australian Commonwealth from 1928 to 1934, was killed in an automobile accident on January 13. He was fifty-five years old.

DR. BINDO DE VECCHI, professor of pathological anatomy and rector of the University of Florence, died on December 28 at the age of fifty-nine years.

A MEETING in commemoration of the late Dr. W. McKim Marriott was held at the Washington University School of Medicine, St. Louis, on January 3. The speakers included: Chancellor George R. Throop; Dr. Edwards A. Park, professor of medicine of the Johns Hopkins University School of Medicine; Dr. Alexis F. Hartmann, professor of pediatrics at Washington University, and Dr. Philip A. Shaffer, professor of biological chemistry and head of the department, Washington University School of Medicine.

SCIENTIFIC EVENTS

THE ANNUAL REPORT OF THE BRITISH MINISTRY OF HEALTH

THE annual report of the British Ministry of Health has been recently issued. The year 1935–36 was a period of outstanding health records. The death rate for infants under one year, at 57 per 1,000 births, and deaths from tuberculosis—fewer than 30,000—were the lowest on record. The maternal mortality rate, at 3.93 per 1,000 births, was the lowest since 1924.

According to a summary in the London *Times*, Sir Kingsley Wood, minister of health, said that:

Perhaps the important development in public health was that more and more they were not only seeking to prevent ill-health and disease, but were taking many measures to build up actively good health in the citizens, and adopting a positive policy which promoted directly healthy lives and living. In other words, they were concerned not only with prevention but with building. It was a policy of building up the citizen himself.

During the year over 250,000 expectant mothers had attended ante-natal clinics, and increased use had been made of infant welfare centers. But more must be done in regard to children between one and five years of age. Food was another factor of great importance. Nearly 150,000 samples of food and drugs were analyzed by public analysts during the year. It could be said that adulteration was disappearing, that the food supply was generally free from harmful ingredients, and that the customer was getting what he was entitled to get—good and wholesome food. As well as this, scientific investigation into the nourishment of the population was being carried on by the Advisory Committee on Nutrition.

The collection of family budgets, which is part of the Ministry of Labor's investigations into the cost of living, will provide much useful information about dietaries, but the Advisory Committee desired also that a number of quantitative dietary surveys should be carried out. I have asked local authorities to make these surveys, though the cost will, of course, be borne by the ministry.

A wonderful transformation had been worked in the water position by the £1,000,000 grant, and so far as our great industrial areas were concerned everything was perfectly satisfactory. There was now no danger of drought. Much more provision had been made for open spaces, parks, recreation grounds, playing fields and swimming pools. Loans sanctioned for these purposes during the last 12 months were some £2,300,000, and in addition nearly 250 acres of land for purposes of this kind were presented to the local authorities or to the National Playing Fields Association.

The work of preventing bad health must also be continuously pursued. This was particularly true in connection with housing. Already some 500,000 slum dwellers had gone to better, more decent homes. And every month now between 20,000 and 25,000 other slum dwellers were following them into these better conditions.

Smallpox has now been stamped out in this country. The one case in 1935 was the lowest recorded figure since 1918. They hoped to see more progress made against cancer, which was not yet defeated. Another "weak point in the armor" was maternal mortality, but there had been wonderful improvement in the last few years and steady improvement in the last 12 months.

THE NEW YORK BOTANICAL GARDEN

A REPORT of the past year's work of the New York Botanical Garden was presented on January 11 at the annual meeting of the board of managers by Dr. H. A. Gleason, deputy director, who is at present carrying on the work of Dr. Marshall A. Howe, who died on December 24.

According to his report, extensive reconstruction of Conservatory Range No. 1 on the west side of Bronx Park, commenced early this year, covering approximately two acres of ground, where thousands of exotic plants of decorative, botanical and economic interest are kept for public display, makes this conservatory one of the largest public greenhouses in the world. Its reconstruction—which will be carried out in such a way that at no time will the exhibits be sacrificed—will result in more effective showing of the collections.

The beauty of the grounds of the Botanical Garden will also be enhanced by more than a thousand trees and shrubs which were set out during the fall and by 800 young hemlocks which were added to the forest along the Bronx River. In the Thompson Memorial Rock Garden, one of the most frequently visited portions of the grounds, a bog area will be planted with special subjects this year and 7,000 heathers will be added to the heath planting. The new iris garden on the west side of the grounds will bloom for the first time this coming spring. Six thousand plants in 181 varieties comprise the collection.

Each member of the garden will receive, beginning this year, a subscription to *Addisonia*, which contains colored plates and descriptions of unusual plants. This will be in addition to the monthly *Journal* and the other privileges of membership.

A memorial resolution to the late Dr. Marshall A. Howe, director, was adopted by the board before the close of the meeting, as well as a resolution honoring Dr. Lewis Rutherfurd Morris, a member of the board who died toward the end of the year.

Henry W. De Forest, who has been president of the garden since 1928, was reelected, and Henry De Forest Baldwin was reelected vice-president.

ANNUAL REPORT OF THE SECRETARY OF THE SMITHSONIAN INSTITUTION

IN the annual report for 1936 of Dr. Charles G. Abbot, secretary of the Smithsonian Institution, which has now appeared, he points out that results have been especially encouraging in two fields—the correlation of solar radiation with the weather and the study of the effects of light on plant growth. One was the apparent proof that short-interval changes of the heat output of the sun, such as run their courses in a few days, are of major influence on the weather for the ensuing two weeks or more. Investigators of the U. S. Weather Bureau have agreed with him, Dr. Abbot reported, that investigation of this effect offers reasonable promise of a method of forecasting some features of the weather for two weeks or more in advance. Progress also was reported by Dr. Abbot in the development of his 23-year-cycle weather hypothesis. While much more work must be done in working out the details, he states that certain large and prolonged features, like the great drought in the Northwest, seem to be clearly predictable. Another development has been the working out of a sensitive and quick-acting spectroscopic method for measuring carbon dioxide in the air. By this method the respiration and carbon dioxide assimilation of a single grain of wheat in its germination is readily observed.

Nearly half a million specimens were added to the collections of the National Museum, mostly as gifts or from Smithsonian expeditions. One of these was the Richard K. Peck collection of ethnological material from the Negritos and Papuans of Dutch New Guinea, the Dyaks of Borneo and the Jivaro of Ecuador. In biology there was an accession of 465 mammals from Asia, Africa and South America, obtained by exchange with the Field Museum of Natural History. In geology a collection of Chilean minerals, including six new varieties, was obtained. The airplane *Winnie Mae,* flown by Post and Gatty around the world, was added to the arts and industries collection.

The Bureau of American Ethnology continued its researches at the recently discovered site of Folsom man in Colorado, the earliest known human settlement in North America. Archeological discoveries were made in Honduras by a joint Smithsonian-Peabody Museum expedition. A culture level was found that is apparently ancestral to that of the Maya. Among ethnological investigations were studies of the Timucua and the Indians of Hudson's Bay, Canada, the Mission Indians of California, the Shoshone, Bannock and Gosiute of Utah, Nevada and Idaho and the Iroquois of Canada.

The Smithsonian's International Exchange Service acts as the official United States agency for the exchange of scientific publications with foreign countries. During the past year this exchange involved the handling of over half a million packages.

At the National Zoological Park the outstanding event of the year was the beginning of construction of three new buildings under a grant from the Public Works Administration. These are a building for small mammals and great apes; one for elephants, rhinoceroses and hippopotamuses, and a new wing for the bird house. Over two million visitors went to the park during the year, including groups from 570 schools.

The Smithsonian Astrophysical Observatory continued to record the variations in the sun's heat at its three mountain stations, in California, Chile and Egypt. A new method of distinguishing unfavorable sky conditions was developed during the year, which will lead to even greater accuracy in measuring the sun's variability.

Besides the usual scientific publications, a weekly radio broadcast on the activities of the institution has been put on the air by the Office of Education in cooperation with the National Broadcasting Company.

THE CHARLES HAYDEN FOUNDATION

THE late Charles Hayden, of New York City, left his entire estate, estimated at about $50,000,000, with the exception of several specific bequests, to establish The Charles Hayden Foundation for the education of boys and young men and the advancement of their "moral, mental and physical well-being," and for other purposes.

A gift of $1,000,000 is made to his alma mater, the Massachusetts Institute of Technology, and outright bequests amounting to $647,000 to various friends. A trust fund of two million dollars is left to his brother, Josiah Willard Hayden, of Boston; a $500,000 trust fund to a friend, and three other small trusts for friends and employees are established. In each case the principal of these trusts reverts eventually to the foundation.

The objects of the foundation are given as follows:

1.—To assist needy boys and young men.

2.—To assist in charitable and public educational purposes for the moral, mental, physical and intellectual well-being, uplifting and upbuilding of boys and young men of this country.

3.—To found or provide scholarships for deserving boys and young men in this country, and for graduates or undergraduates of colleges, and to assist them in attending any educational institution in this country or abroad.

4.—To assist in or to found, equip and provide for the maintenance of institutions or associations for the advancement of learning in this country.

5.—To assist, build, equip and maintain gymnasia, clubs and recreation centers in this country for the training of boys and young men.

6.—To assist, and to receive, hold, administer and dispose of property to or for the benefit of any university, college, school or other institution for the advancement of learning or of any branch or department thereof, or for the benefit of any hospital or of any branch or department thereof.

Mr. Hayden placed no restrictions upon the use of the principal of his estate, but he did request that the greater part of the principle be so conserved that the benefits of the foundation might be extended to future generations.

"In the disposition of income and such principal as need be," he wrote, "preference shall be given to the furtherance of the foregoing objects within the City of New York and the City of Boston, but nothing contained herein shall be construed to prevent the aiding of such activities anywhere else in this country."

THE WASHINGTON AWARD

THE Washington Award Commission has voted to confer the 1937 award on Dr. Frederick Gardner Cottrell, of Washington, D. C., who was formerly director of the U. S. Bureau of Mines and director of the Fixed Nitrogen Laboratory of the U. S. Department of Agriculture. Dr. Cottrell is known for his work in helium production, in nitrogen fixation, for his processes of cleansing gases of dust and dirt by electrical precipitation and for research in petroleum technology. The award has been made for his "social vision in dedicating to the perpetuation of research the rewards of his achievements in science and engineering." He is the fourteenth American engineer to receive the award since it was founded in 1916 by John Watson Alvord, of Chicago.

The annual Washington Award, an honor conferred "on a brother engineer by his fellows for accomplishments which pre-eminently promote the happiness, comfort and well-being of humanity," is administered by the Western Society of Engineers in cooperation with the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. The tangible symbol of the award is a bronze plaque mounted in marble. This will be presented formally to Dr. Cottrell at a dinner on February 23.

Those who have received the Washington Award since its foundation are as follows:

1919—Herbert C. Hoover, "for his preeminent services in behalf of the public welfare."

1922—Robert W. Hunt, "for his pioneer work in the development of the steel industry and for a life devoted to the advancement of the engineering profession."

1923—Arthur N. Talbot, "for his life work as student and teacher, investigator and writer and for his enduring contribution to the science of engineering."

1925—Jonas Waldo Smith, "for the rare combination of vision, technical skill, administrative ability and courageous leadership in engineering."

1926—John Watson Alvord, "for his pioneer work in developing the fundamental principles of public utility valuation and his marked contributions to sanitary science."

1927—Orville Wright, "for fundamental scientific research and resultant successful airplane flight."

1928—Michael Idvorsky Pupin, "for devotion to scientific research leading to inventions which have materially aided the development of long-distance telephony and radio broadcasting."

1929—Bion Joseph Arnold, "for pioneering work in the engineering and economics of electrical transportation."

1930—Mortimer E. Cooley, "for vision and constructive leadership in the education of the engineer."

1931—Ralph Modjeska, "for his contribution to transportation through superior skill and courage in bridge design and construction."

1932—William David Coolidge, "for his scientific spirit and achievement in developing ductile tungsten and the modern x-ray tube."

1935—Ambrose Swasey, "for his distinguished contributions as a builder of instruments, institutions and men."

1936—Charles Franklin Kettering, "for his high achievements in guiding industrial research toward the greater comfort, happiness and safety of mankind in the home and on the highway."

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

NEW officers of the American Society of Civil Engineers who take office at the eighty-fourth annual meeting of the society being held in New York from January 20 to 23 are as follows:

Louis C. Hill, consulting civil engineer, of Los Angeles, Calif., *president*, succeeding Dr. Daniel W. Mead, professor emeritus, hydraulic and sanitary engineering, University of Wisconsin; Commander Lyle F. Bellinger, U. S. Navy (retired), *vice-president*, succeeding Colonel D. H. Sawyer, Washington, D. C.; Roy C. Gowdy, Denver, *vice-president*, succeeding Professor Henry E. Riggs, University of Michigan. New directors are: Colonel William J. Shea and Enoch R. Needles, New York;

Arthur W. Dean, Boston, Mass.; Dean Roland P. Davis, College of Engineering, West Virginia University; T. Keith Legaré, Columbia, S. C., and Thomas E. Stanton, Jr., Sacramento, Calif.

Medals will be presented for distinguished work in the field of civil engineering as follows:

Dr. Arthur Newell Talbot, professor emeritus of engineering at the University of Illinois, the John Fritz Medal.

Dr. Daniel W. Mead, of Madison, Wis., the Norman Medal, for a report on the St. Lawrence water-power development.

Wilbur M. Wilson, research professor at the University of Illinois, the J. James R. Croes Prize, for the second best report.

A. V. Karpov, of the Aluminum Company of America, Pittsburgh, and R. L. Templin, chief test engineer of the same company, the Thomas Fitch Rowland Prize, for a report on construction work.

Paul Baumann, chief engineer of the Los Angeles County Flood Control district, the James Laurie Prize, for a report on sheetpile bulkheads.

Clinton Morse, of Balboa Heights, Canal Zone, the Collingwood Prize, for a report on engineering work.

Honorary membership will be conferred on Alex Dow, of Detroit; G. H. Duggen, of Montreal; Robert Hoffmann, of Cleveland; J. B. Lippincott, of Los Angeles, and J. A. L. Waddell, of New York.

SCIENTIFIC NOTES AND NEWS

FOLLOWING the Harvard Tercentenary the French Government conferred membership in the Legion of Honor with the rank of commander on President James Bryant Conant. Professor George D. Birkhoff, Professor Julian L. Coolidge, Professor James B. Munn and Jerome D. Green, director of the tercentenary, have been promoted from the rank of chevalier to that of officer of the legion. The rank of chevalier has been conferred on Professors Bliss Perry, Edward B. Hill, Edward W. Forbes, Roger Bigelow Merriman, Ralph Barton Perry, Edward A. Whitney, Kenneth J. Conant and George Harold Edgell.

DR. CUSTIS LEE HALL, assistant professor of orthopedic surgery in the George Washington University School of Medicine, Washington, D. C., was presented on January 4 with the first Citizens' Service Award for 1936. The cup, which will be awarded annually to the citizen who is considered to have rendered the most unselfish service to the whole community, is provided by the Washington *Times;* the recipient is selected by a representative citizens' committee. Dr. Hall was chosen for his work among crippled children and adults.

THE $1,000 prize and bronze medal of Eli Lilly and Company was presented on December 29 at the Indianapolis meeting of the Society of American Bacteriologists to Dr. Harry Eagle, of the Johns Hopkins Hospital, for research on immunity to various diseases, notably syphilis. The prize is awarded by a committee of the Society of American Bacteriologists, the American Association of Immunologists and the American Society for Experimental Pathology.

DR. LEROY M. S. MINER, dean of the Harvard Dental School and president of the American Dental Association, received a medallion "in recognition of outstanding service of benefit to dentistry during the past year" at the annual convention of the dental fraternity, Alpha Omega, held in Boston from December 29 to 31.

GEORGE DAVID OBERLE has been awarded the annual research prize of the Kansas State College Chapter of the Society of Sigma Xi for his work on "The Influence of Leaf to Fruit Ratios on the Photosynthetic Activity of York and Livland Apple Leaves." This prize is awarded annually by the society to a graduate student at Kansas State College who makes the most significant scientific contribution during the year.

THE Melchett Medal of the Institute of Fuel, London, has been awarded to Dr. Franz Fischer, director of the Kaiser Wilhelm Institute for Coal Research.

JAMES G. K. MCCLURE, JR., of Asheville, N. C., has been elected president of the American Forestry Association, succeeding Dr. Henry S. Graves, dean of the Yale Forest School and formerly chief of the Forest Service, who retired on December 31. At the same time the association announced the election of four new directors: Karl T. Frederick, of New York, president of the New York State Conservation Council, to serve for five years; Joseph H. Pratt, of Washington, D. C., formerly president of the Southern Forestry Congress, to serve for two years; Wilbur K. Thomas, of Philadelphia, executive secretary of the Carl Schurz Memorial Foundation, to serve for two years; and Wallace W. Atwood, president of Clark University and formerly president of the National Parks Association, to serve for one year. Dr. Graves was elected to serve as a director for a period of five years, and Dr. John C. Merriam, president of the Carnegie Institution of Washington, was reelected to serve for a five-year period.

DR. RAYMOND W. WAGGONER, associate professor of neurology at the University of Michigan Medical School, who was recently made director of the State Psychopathic Hospital, has been promoted to a pro-

fessorship and has been made director of the department of psychiatry.

A SHELDON traveling fellowship in geology has been awarded by Harvard University to Fred B. Phleger, Jr., of Glendale, Calif., a graduate of the University of Southern California and of the California Institute of Technology.

THE departments of botany of Cornell University and of the Ohio State University have arranged an exchange of instructors for the spring term of the current academic year. Dr. E. M. Palmquist, of Cornell University, and Dr. C. E. Taft, of the Ohio State University, have been selected for the exchange. Both instructors will be engaged in the teaching of general botany in the large elementary courses.

DR. LAWRENCE GAHAGAN has resigned from an assistant professorship of psychology in the University of California at Los Angeles in order to take up the study of medicine.

DR. LANCELOT HOGBEN, professor of social biology in the University of London, has been appointed Regius professor of natural history in the University of Aberdeen in place of Professor James Ritchie, who has resigned.

DR. JOHN ALFRED RYLE, Regius professor of physic in the University of Cambridge, has been elected to a professorial fellowship at Gonville and Caius College.

DR. WILLIAM BOWIE, chief of the division of geodesy of the U. S. Coast and Geodetic Survey, who will be sixty-five years old next May, has retired. He joined the survey in 1895 as a field engineer.

DR. ALONZO E. TAYLOR, director of the Food Research Institute at Stanford University since 1921, has been appointed chairman of the research committee of General Mills, Inc., Minneapolis.

DR. MORLEY A. JULL, head of the poultry department of the University of Maryland, has been elected secretary of the Industry Committee of the seventh triennial World's Poultry Congress, that will be held for the first time in the United States in 1939.

PRESIDENT ROOSEVELT sent to the Senate on January 11 the nomination of Charles Edison, of New Jersey, son of Thomas A. Edison, to be Assistant Secretary of the Navy.

FRANK A. ARNOLD has been appointed managing director of the Technical Press of the RCA Institutes, Inc. He will direct the publication of the *RCA Review*, a quarterly journal of radio progress.

DR. JOHN H. GEROULD, who is on leave of absence from Dartmouth College, will be at the Imperial College of Tropical Agriculture, Trinidad, from February 7 until April 15, 1937.

LLEWELYN WILLIAMS, assistant curator of economic botany at the Field Museum, Chicago, left early in January on an expedition of several months in southern Mexico to obtain general botanical collections for the museum. The expedition was made possible through cooperation extended by F. J. Riker, president of Maderas Tropicales, South America, a division of the Ozark Corporation, Detroit. Work will be concentrated on the Isthmus of Tehuantepec, especially in the region of Minatitlan, in the state of Vera Cruz.

SIR HUBERT WILKINS, the Arctic explorer, returned to England, after visiting the United States, on January 3. He hopes to raise £10,000 there to complete the sum needed to construct the submarine in which he intends to cross the Arctic under the ice. He has already received the sum of £25,000 towards the cost.

MISS L. E. CHEESMAN has returned to England after a year's absence, during which she made a collecting expedition to Dutch New Guinea to obtain specimens for a research into the insect fauna of the Cyclops Mountains and to collect scientific material for the British Museum of Natural History.

THE Gehrmann lectures of the College of Medicine of the University of Illinois will be delivered on January 25, 26 and 27 by Dr. Thomas Parran, Surgeon General, U. S. Public Health Service. The subjects of the individual lectures are: "Health as a Factor in Social Security," "Industrial Hygiene" and "Syphilis."

DR. ELMER V. MCCOLLUM, professor and head of the department of biochemistry at the Johns Hopkins University School of Hygiene and Public Health, will deliver at Detroit on February 15 and 16 the annual Beaumont Lectures of the Wayne County Medical Society. His subject is "Recent Advances in the Field of Nutritional Research."

THE address at the fall initiation meeting of the Ohio State University Chapter of the Society of the Sigma Xi was on December 7 delivered by Dr. Laurence H. Snyder, professor of zoology. His subject was "Questions and Answers."

THE two hundred and twelfth regular meeting of the American Physical Society will be held on Friday and Saturday, February 19 and 20, at Chapel Hill and Durham, N. C., in affiliation with the Southeastern Section of the American Physical Society and the American Association of Physics Teachers. Other meetings for the current season are as follows: Washington, D. C., April 29 to May 1; Pacific Coast, time and place not yet decided; Madison, Wis., June 22 and 23.

AN International Congress on Hepatic Insufficiency and Liver Diseases is to be held at Vichy, France, on

September 16, 17 and 18. Dr. Anthony Bassler is the chairman of the American committee of the congress. The American group will present papers on "The Relation of Hepatic Insufficiency to General Nutrition and Especially to the Nervous System." Those taking part are Dr. Anthony Bassler, New York; Dr. Hyman I. Goldstein, Camden, N. J.; Dr. Andrew C. Ivy, professor of physiology and pharmacology, Northwestern University Medical School; Dr. Lathan A. Crandall, Jr., Chicago, and Dr. Norman W. Elton, Reading, Pa. This congress will follow the second International Congress on Gastroenterology, which meets at Paris on September 13, 14 and 15.

A UNITED PRESS dispatch from Moscow reports that three hundred and sixty-nine foreign geologists, representing forty-six countries, have signified a desire to participate in the International Congress of Geology to be held in Moscow this summer. Most of the participants—one hundred and thirty-six—will go from the United States. The desire to attend was reported also by thirty-three English, twenty-six French, twenty German and sixteen Spanish geologists and by a number of geologists from Italy, Switzerland and other countries. It is reported that the program will include a hundred and fifty papers by foreigners and about two hundred and fifty papers by Russian geologists.

THE fourth International Grassland Congress will be held in Great Britain in July under the presidency of Professor R. G. Stapledon, director of the Welsh Plant Breeding Station and the Imperial Bureau for Herbage Plants, Aberystwyth. Delegates will attend from Great Britain, the British Dominions and Colonies, the United States and numerous other countries. The paper-reading sessions will be held in Aberystwyth from July 13 to 19, but participants will be able to join in a tour of centers of grassland interest and selected farms both before and after these sessions. Delegates will be able to choose one of a number of options to take part in the whole congress or certain sections of it. Special addresses will be given on certain evenings at Oxford, Cirencester, Aberystwyth and Newcastle. The paper-reading sessions to be held in Aberystwyth will be divided into three plenary and two sectionalized sessions. The latter will deal with numerous aspects of the grassland problem, including ecology, pasture and range management, seed mixtures, plant breeding, genetics and seed production, manures and fertilizers, nutritive value of pastures, fodder conservation and grassland economics.

THE first International Conference on Fever Therapy will be held at Columbia University College of Physicians and Surgeons, New York, from March 29 to 31. The program is divided into four parts with committees in charge as follows: physiology, pathology and methods of production of fever, Drs. Frank W. Hartman, Detroit, *chairman,* and Charles A. Doan, Columbus, Ohio, *secretary of the committee;* miscellaneous diseases treated by fever therapy, Drs. Clarence A. Neymann, Chicago, *chairman,* and Frank H. Krusen, Rochester, Minn., *secretary;* syphilis, Drs. Walter M. Simpson, Dayton, Ohio, *chairman,* and Leland E. Hinsie, New York, *secretary;* gonorrhea, Drs. Stafford L. Warren, *chairman,* and Charles M. Carpenter, *secretary,* Rochester, N. Y.

AN exhibit from the Carnegie Institution of Washington was opened at the Museum of Science and Industry, New York City, on the evening of January 14, with a preview for trustees of the museum, scientific men, engineers and other invited guests. The exhibition shows among other things research in the exploration of the earth's high atmosphere with radio waves; the present-day Maya Indians of Yucatan; pinocytosis, the drinking of fluids by cells; the march of forests in response to changing climate; new factors in animal metabolism, the formation of copper ores, etc. There will be moving exhibits, motion pictures, lectures, transparencies, etc.

THE Museum of Natural History of Syracuse University, containing large and valuable scientific collections, was destroyed by fire which swept the top floor of Lyman Hall, housing the university's natural science laboratories, on January 1. The damage is estimated at $450,000. The fire first was observed in the office of Dr. Ernest Reed, head of the department of botany, who is in Venezuela on a scientific expedition. In the museum were specimens of the university's first Andean expedition, including stuffed animals, rocks and geological specimens; collections from Venezuelan expeditions; fifty or more rare plants as yet unidentified; a collection of Mayan and Aztec idols; the university collection of African mammal horns, valued at $2,000, a recent purchase; a collection of minerals, valued at $20,000; complete "file" of mounted birds of this locality; a set of miniature African mammals from the American Museum of Natural History; a collection of carved pieces of South Sea Island ivory; taxidermy equipment, microscopes and stereopticon slides; letter and manuscript files; a collection of shells; an "almost priceless" collection of first editions describing the natural history of New York State; three large skeletons of extinct reptiles.

AT the annual meeting held at Atlantic City on December 30, 1936, the Genetics Society of America passed the following resolution: "The Genetics Society of America records its regret that it appears impossible to hold the meeting of the Seventh International Congress of Genetics in the summer of 1937 as

planned; and in view of the importance of maintaining friendly contact among the geneticists of all countries through regular international congresses it urges that the International Committee arrange for holding the Seventh International Congress at the earliest practicable time."

DISCUSSION

THE SAN DIEGAN ALLIGATOR LIZARD AND THE BLACK WIDOW SPIDER

TOWARD the end of 1935, or early in 1936, local newspapers carried several accounts of a contemplated introduction of *Bufo marinus* to California, to act as a biological control of the black widow spider, *Latrodectus mactans*. That such an attempt might actually be made seems possible, owing to the scare notices which periodically appear in California, claiming that this dangerous spider is on the increase.

While considering the feasibility of introducing this toad and the dangers attendant upon such a procedure, it seems proper to visualize it and its manners of attacking a spider. To one knowing something of the habits of the black widow, such a contemplation conjures up a picture of a robust toad squeezing into cracks under boards and stones, crawling up the studding in garages and homes, clambering into dense shrubs and hedges, leaping nimbly into the air to pick the spiders from the center of their webs, and in other ways behaving in a manner not at all compatible with bufonid temperaments and capabilities. The few spiders found wandering about on the grounds and accessible to the toads would be so small in number as to form only an inconsiderable percentage of the whole population.

After giving some study to the problem of a possible native predator it appeared highly probable that the habits of the San Diegan alligator lizard, *Gerrhonotus multicarinatus webbii*, in southern California, and other subspecies elsewhere in the state, would bring this reptile into close contact with the spiders. This lizard, on close study, also appeared to be the only animal with a habitat approximating that of the black widow.

It was hoped that a study of stomach content might furnish evidence in support of the theory that the lizard is an important predator on the spiders, but it is obvious that only by very remote chance would one find even the chelicerae in the digestive tract of the lizard. Adult spiders, in spite of all the alarms, are too scarce to form an important element in the diet of *Gerrhonotus*.

Although studies in food habits carried on with captive specimens are, or should be, considered subject to serious questioning (as witness our desert tortoise, *Gopherus agassizii*, eating cheese, apples, bananas and lettuce in captivity), in this case, the method appeared our only hope of obtaining any light on the problems under scrutiny.

Although more work on this problem will be undertaken during the coming year, it is not believed that anything but confirmation of our initial results will be forthcoming. In the early attempts, it was found that the female spiders of any size were eagerly consumed by *Gerrhonotus*, and that all healthy and active specimens fed readily. This, in itself, might not be significant, but in view of the repeatedly observed response of the lizard to the egg sacs of the spider, it is believed that this lizard may be the chief vertebrate enemy of the black widow. Every egg sac, whether containing eggs or young, when placed in the lizard's cage, was consumed. The lizard often showed an almost immediate response to the presence of such an inanimate object and would swallow the entire sac as well as the contents. Such behavior is particularly significant to any one who is familiar with these lizards, since they will be aware that this species is ordinarily responsive only to moving objects and that this feeding habit is therefore particularly significant. After conducting the feeding experiments with *Gerrhonotus*, a specimen of *Sceloporus occidentalis biseriatus* was given an opportunity to feed, and the spider was taken with great readiness. It is probable that many other species of lizards would likewise do so, but it is highly improbable that any of them would be as important an enemy of the spider as *Gerrhonotus*, owing to the fact that none of them fits as neatly into the requisite habitat. It is only a remote chance that our other species of lizards would figure as controls of the black widow.

As has been previously stated, it is commonly reported that the black widow spider is on the increase in southern California, and there has been much informal discussion of the subject. That there has been a total increase is entirely probable, since every new building, at least those erected in open country, should furnish more sanctuary than would the same area without a house. Most of the claimants for the increasing abundance theory seem to believe that there has been not only a general increase, but an actual increase in the density of the population within the habitat as well as in total numbers.

Since there are no population counts compiled at any time in the past, there can be no satisfactory method of comparing conditions of ten or twenty years ago with the present; therefore, there can be no solution to this phase of the problem. Theoretically, however, any decrease in the number of parasites and predators would result in an increase in the density of population, irrespective of increase in available areas. If there has been no decrease in parasite effectiveness, but if there has been a reduction in the number of effective predators, we would expect that there might be an actual temporary increase in the density of the spider population, which would continue until the additional food supply made available to the parasite would act on the population of these organisms, accelerating their rate of increase to meet the newly created opportunity for multiplication. That we may be in a stage where there are more spiders available and where the parasites have not yet increased to their maximum numbers seems entirely possible.

So far as one may judge, all gardeners, amateur and professional, are 99.9 per cent. antagonistic to all reptiles, and the unfortunately snake-like *Gerrhonotus* is apparently particularly obnoxious to these active outdoor people. Although the above percentage may not be exact, at least one seldom hears of any evidence indicating a friendly attitude on the part of the non-herpetologist to this lizard. Unfortunately, even though the gardeners might be amenable to a herpetological conversion, the clean, cultural methods involved in gardening and cultivation of the ground are both inimical to an increase in the number of lizards. Another factor which may have a bearing on numbers of these useful animals is the predatory skill of our domestic cat. Although our spiders are so much feared and although the lizards may be an important control device, it is not believed that even though this information is disseminated there will be any marked shift in the choice of pets, at least not on the part of those who, at least since Darwin's time, have enjoyed the company of cats. In the writer's own experience, cats are serious enemies of this as well as other species of lizards. Again, in the writer's experience, it appears to be probable that the protection and introduction of *Gerrhonotus* will result in a decreasing population of the black widow spider. Too many uncontrolled factors enter into the present discussion, but it might be mentioned here that five years ago the writer's house was thoroughly popular with black widow spiders. An effort to reduce their numbers made little impression on the population. At the same time, however, an effort was being made to increase the numbers of the San Diegan alligator lizard. Individuals of this species were introduced onto the place; cats were carefully driven away; and clean cultural methods were not employed. As a result, the population of the alligator lizard increased considerably. Five years later, when spiders were needed for the present experiment, it was found that the black widow was extremely scarce; hardly any specimens could be found on the writer's property. That this may have been due to an increase in the number of parasites is recognized; but it may also have been due to the presence of an unusually large number of *Gerrhonotus*. Particularly significant is the fact that in the garage, where spiders were particularly abundant, *Gerrhonotus* was repeatedly found climbing about within the building, even as high as the top of the garage door, approximately eight feet from the ground. Here the lizard would lie in the narrow space between the top of the door and the lintel, where occasionally they were crushed by the closing of the doors. Although the evidence in this case is circumstantial, it appears probable that the friendly protection and encouragement of the San Diegan alligator lizard and, incidentally, the elimination of cats, might be of considerable benefit to the population of southern California.

RAYMOND B. COWLES

UNIVERSITY OF CALIFORNIA
AT LOS ANGELES

NOTES ON THE DISTRIBUTION OF THE BLACK WIDOW SPIDER

IN Donald C. Lowrie's note in SCIENCE for November 13, 1936, "New Localities for the Black Widow Spider," Minnesota, Iowa, Virginia, Delaware, New Jersey, Connecticut, Rhode Island and Vermont are listed as the only states from which this spider has not been officially recorded.

However, it may be noted that this spider must be fairly prevalent all over the state of Virginia, as stated by G. W. Jeffers in SCIENCE for December 11, 1936, and has been recorded by Anderson and Walker,[1] C. R. Willey[2] and W. J. Schoene,[3] as well as noted in the article by C. E. Burt in the *Journal* of the Kansas Entomological Society (8: 4, 117, 1935).

In addition this spider has been recorded from New Jersey by C. H. Headlee[4] in 1935, from Connecticut by W. E. Britton[5] in 1935 and from Rhode Island by A. E. Stene[6] in 1936.

H. L. Bailey informs me that this spider has been collected in Springfield, Vermont, in the fall of 1936 (identification verified by C. R. Crosby, of Cornell

[1] L. D. Anderson and H. G. Walker, *Bulletin*, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, Insect Pest Survey, 12: 404, 1932.
[2] C. R. Willey, *ibid.*, 14: 9, 296, 1934.
[3] W. J. Schoene, *ibid.*, 15: 7, 359, 1935.
[4] C. H. Headlee, *ibid.*, 15: 8, 389, 1935.
[5] W. E. Britton, *ibid.*, 15: 6, 318, 1935.
[6] A. E. Stene, *ibid.*, 16: 6, 306, 1936.

University). Also Paul L. Rice, of the Delaware Agricultural Experiment Station, states that he and Donald MacCreary have frequently observed this spider near Camden and Wilmington in the fall of 1936.

Letters from Clarence E. Mickel, of Minnesota, and C. J. Drake and H. E. Jaques, of Iowa, report that they have no records of this spider having been found in their states, but that it probably occurs there. Thus Minnesota and Iowa are the only states from which this spider had not been recorded.

L. D. ANDERSON
H. G. WALKER

VIRGINIA TRUCK EXPERIMENT STATION
NORFOLK, VA.

WESTERN HIGHWAY HAZARD FOR JACK RABBITS

WHILE passing over the highways of Idaho one is usually impressed by the great number of jack rabbits which have been killed by automobiles. On November 17, 1936, the writers passed through the Hagerman Valley, where dead jack rabbits were especially numerous along the highway, and a count of dead rabbits the following day showed that 154 had been killed by automobiles in three tenths of a mile. It was evident that they had been killed within a few days, as otherwise they would have been devoured by the scavenger crows and magpies.

At the point where the count was made, there was a stack of alfalfa hay in a small alfalfa field on one side of the road, while on the other side sagebrush extended back for miles. The fall weather had been unusually dry, so there was no green vegetation amongst the sagebrush. It therefore appears that at this place the jack rabbits had been attracted to the alfalfa and had subsequently met their death.

A. O. LARSON
D. E. FOX

BUREAU OF ENTOMOLOGY AND
PLANT QUARANTINE
U. S. DEPARTMENT OF AGRICULTURE

PROTECT DIONAEA MUSCIPULA

Dionaea muscipula Ellis or Venus fly-trap is not only one of the most interesting biological objects but is also a plant species that is strongly endemic. It has been reported from the environment of Wilmington, N. C., and from a few localities in South Carolina.

I was frequently able to visit this region, especially around Wilmington. In many places here this plant has become extinct. In fact, during the last three years I was able to witness the disappearance of plants over several fields. An important reason for its disappearance is that a considerable part of its natural habitation is being artificially drained to aid agriculture, the result being that we find on the remaining land another type of vegetation which threatens the existence of *Dionaea* very distinctly, whereas, in other places, we observe a modification of plant associations, although *Dionaea* still remains.

It would be very desirable that some typical parts of that interesting country should be protected before it is too late. The land of that neighborhood is cheap. Its purchase by state or government would offer no objections.

J. C. TH. UPHOF

ORLANDO, FLA.

CUSCUTA NOT A COMPLETE PARASITE

Too often, when a false statement creeps into a book, it is copied and passed along. Thus it is, again and again, when a new text on botany appears, once more appears the statement that Cuscuta is a complete parasite devoid of chlorophyll. Though I make no claim to having read every American text-book on botany, I believe I have seen the majority of them, and with no exception, these state that cuscuta is devoid of chlorophyll.

Dodder is a phanerogam, Convolvulaceae. Its seed germinates somewhat differently from others of that family, for it sends forth a green (protonema-like) filament, which runs over the surface of the ground, drying at the seed end as it grows, until it reaches a succulent host, whereon it twines and forms haustoria. Then its stems become somewhat brownish, but the areas where haustoria are functional are still quite green. In midsummer it blooms. Its buds also are quite green, its fruits very green.

Alcoholic and ether extracts would show that the fruits have as much chlorophyll as any other convolvulaceous plant, its buds nearly as much, its haustellate areas about half as much and other parts of the stem a little. Inasmuch as plants with little chlorophyll produce more carbohydrate per unit than those with much chlorophyll, it is quite likely that Cuscuta may be able to sustain itself on its own organic foods, as does mistletoe. Let some physiologist solve that problem.

Dr. Louis Knudson in a personal conversation stated he had grown dodder on nutrient agar unsuccessfully unless a green host plant was supplied. He admitted, however, other factors might be involved.

Cassytha (Lauraceae), often mistaken for Cuscuta, has about the same relative distribution of chlorophyll. Cuscuta and Cassytha are green plants, even though they are parasites. They do contain chlorophyll, both alpha and beta. Strasburger states they have chlorophyll.

F. A. VARRELMAN

NEW YORK BOTANICAL GARDEN

REPORTS

ACTIVITIES OF THE COMMONWEALTH FUND

IN its annual report for the year ending September 30, 1936, made public on January 18, the Commonwealth Fund records appropriations amounting to $1,967,153.26, intended, in the words of its founder, Mrs. Stephen V. Harkness, "to do something for the welfare of mankind."

More than two thirds of the total was devoted to the betterment of health. Grants were made for public health service to rural communities, rural hospitals, medical education and medical research. Postgraduate education in medicine was emphasized, the fund believing that such work is of major importance in improving the quality of medical service.

For the first time in several years a large share of these appropriations went to educational institutions in New York City. The largest of these was a conditional gift of $250,000 to the College of Physicians and Surgeons of Columbia University, to meet part of the cost of enlarging laboratory facilities at the Columbia-Presbyterian Medical Center for graduate teaching in the medical specialties. The fund also continued to help in financing a study, sponsored by the New York Academy of Medicine, of medical education in New York hospitals.

As part of its mental hygiene program the fund contributed to educational activities at the Babies Hospital and the New York Hospital. A similar project at the Children's Hospital in Boston is also being supported by the fund.

The fund continued to work through various channels for the improvement of medical practice in rural areas, particularly in Tennessee, Mississippi and the northern New England states. In all, 379 scholarships have now been awarded to physicians for postgraduate study at Harvard, Tulane, Vanderbilt and other medical schools.

In the belief that improvement in rural medical service will be hastened if newly trained physicians enter practice in country districts, the fund offers scholarships to undergraduates in medicine at Tulane, Vanderbilt and Tufts. Thirty-nine scholarship holders have now been graduated and seven have completed their internships and have entered practice, in accordance with the terms of the grant, in towns of less than 5,000. Twelve or more well-trained young physicians will be ready for rural practice each year in the three states, Mississippi, Tennessee and Massachusetts, where these scholarships are offered.

Nine years ago the fund began to build, with local cooperation, small general hospitals in country communities. After six had been completed, the depression interrupted the building program, but this has now been resumed. The seventh hospital, in Kingsport, Tennessee, has been open a year and more than 5,000 persons in a population of approximately 21,000 have already subscribed to a prepayment plan entitling the subscriber to free hospital care or a discount on hospital charges. An eighth hospital is nearing completion in Tupelo, Mississippi, and a ninth has been awarded to Ada, Oklahoma.

During the past year state health department service has been emphasized as the best means of improving local health work. In Tennessee, Mississippi and Massachusetts traveling units have worked under state auspices to supervise and strengthen local health departments or to deal with particular health problems such as communicable disease and tuberculosis. The fund has also helped to finance the development of health departments in two counties in Tennessee, two counties in Mississippi and two town-unions in Massachusetts. These areas are used as demonstration and training centers. In New Mexico the fund has continued to help spread nursing service over the state.

The fund made its first appropriation during the year to a newly organized study of high blood pressure uncomplicated by organic disease, to be directed by Dr. Warfield T. Longcope at the Johns Hopkins University School of Medicine.

Continued appropriations were made for the study of placental extract in the treatment of measles and other virus infections at the Harvard Medical School, of trachoma at Washington University, of rheumatic fever at the New York Hospital and the House of the Good Samaritan, Boston, of tuberculosis at Bellevue Hospital, New York, and at the Harriet Lane Home of the Johns Hopkins University School of Medicine, of kidney function at the University of Pennsylvania, of the chemical nature of insulin at the Johns Hopkins University and of growth and development in childhood at the University of Colorado.

Aid was given to the study of the structure and development of the brain at the Neurological Institute, New York. The fund continued to share in the fight against pneumonia by subsidizing the serum treatment project of the New York State Department of Health, by aiding the Michigan State Department of Health to study special reactions connected with serum treatment and by publishing a handbook for physicians on the serum treatment of this disease.

The legal research committee, headed by George Welwood Murray, sponsored studies in administrative law and legal history.

The fund continued to offer a group of fellowships for British graduate students at American universities, 31 having been appointed this year to spend two years in this country as guests of the fund. The distinguished physicist, William Lawrence Bragg, of the University of Manchester, has been elected to the British Committee of Award which selects these fellows, succeeding Sir Hector Hetherington, vice-chancellor of the University of Glasgow.

Appropriations were made for the training of psychiatrists and psychiatric social workers as a contribution to the progress of mental hygiene in the United States. The fund shared in the support of a central bureau of information about child guidance, under the auspices of the National Committee for Mental Hygiene, and of a study of psychiatric education. Gifts were made to the Welfare Council and to the Family Welfare Committee of New York City.

At the close of the fiscal year, September 30, 1936, the invested assets of the fund had a book value of $42,607,226.31 and a market value of $41,039,182.93. The directors of the fund are as follows: Edward S. Harkness, president; Malcolm P. Aldrich, Samuel H. Fisher, William M. Kingsley, Robert A. Lovett, George Welwood Murray and Dean Sage.

SPECIAL ARTICLES

A CRYSTALLINE VITAMIN A CONCENTRATE

THE non-saponifiable matter from the liver oil of *Stereolepis ishinagi*[1] was dissolved in a suitable solvent and fractionated by freezing at carbon dioxide snow temperatures. A final product, quite distinctly crystalline to the naked eye, was obtained. This material had the rather remarkable value of $E^{1\%}_{1\,cm} = 2{,}000$ (as determined by the Hilger Vitameter-A) while the blue value (determined by antimony trichloride reaction according to the method recommended by the British Pharmacopoeia) was 100,000. It is interesting to note that the ratio between these values is 1 to 50, which is in agreement with the ratio of the rather generally accepted provisional standard values for vitamin A, $E^{1\%}_{1\,cm} = 1{,}600$ and blue value = 80,000 (approx.).

The melting point of the pale yellow crystals was determined by evacuating at low temperatures to remove the last traces of solvent and then *very* gradually warming the cooled bath surrounding the melting point tube. To retard this rise in temperature the bath liquid was placed in a Dewar flask (transparent). The melting point ranged from 5.5° C. to 6° C., a rather satisfactory range since the resulting yellow liquid, or melt, is very viscous even at room temperatures. It is obvious that great accuracy in the determination of the melting point is difficult because of the high viscosity of the liquid.

After standing twenty-four hours with von Hubl's solution, the iodine number was 360, which corresponds to four double bonds; longer standing produced a slightly erratic increase in the iodine number. It is probable that addition to the double bond in the ionone ring is difficult.

Purely preliminary quantitative determinations of carbon and hydrogen in this product seem to indicate a carbon content of approximately 83.5 per cent. and a hydrogen content of approximately 10.5 per cent. (with remaining fraction ascribed to oxygen); these values will be corrected at an early date. Molecular weight determinations as well as biological tests are in progress and will be reported later.

HARRY N. HOLMES
RUTH E. CORBET

OBERLIN COLLEGE
DECEMBER 19, 1936

[1] Ishinagi liver oil furnished through the courtesy of the Mead Johnson Company.

STREAM DOUBLE REFRACTION OF PREPARATIONS OF CRYSTALLINE TOBACCO-MOSAIC PROTEIN

PREVIOUS experiments[1] have indicated that under certain conditions the concentration of tobacco mosaic virus in plant juice shows a high positive correlation with the intensity of stream double refraction produced by the juice. These results and others have indicated that the virus in plant juice may be composed of submicroscopic rod-shaped particles capable of causing stream double refraction.

Stanley[2] has obtained crystal preparations from infective juice which contain a high concentration of virus and has obtained considerable evidence that these crystals are the virus in a crystalline state. We have prepared crystals by means of Stanley's method and by a combination of certain steps in Vinson and Petre's[3] and Stanley's methods. Space does not permit giving the details of this combination method. For brevity the crystals prepared by Stanley's method will be called "Stanley crystals" and those prepared by the combination method "C crystals." It was found that the use of a Zeiss cardioid dark field condenser in

[1] W. N. Takahashi and T. E. Rawlins, SCIENCE, 81: 299–300, 1935.

[2] W. M. Stanley, *Phytopath.*, 26: 305–320, 1936.

[3] C. G. Vinson and A. W. Petre, *Bot. Gaz.*, 87: 14–38, 1929.

the microscope enables one to observe the structure of the crystals much better than is possible when a bright field condenser is used. The Stanley crystals were needle-shaped, appeared to have a granular structure and were admixed with a relatively small number of spheroidal particles. The "C" crystals were also needle-shaped, but were smooth in outline; this preparation appeared to contain fewer spheroidal particles than the Stanley preparation. The spheroidal particles were detected only when the dark field condenser was used. The optical activity of each preparation was determined; that of the Stanley preparation was found to be $[\alpha]_D^{22°}$ per mg nitrogen $= -38$, and that of the "C" preparation was -40. Stanley[2] reported the optical activity of his two samples of crystals to be -42 and -44. The fact that these 4 results are reasonably close, that the crystals are small needles similar to those of Stanley and that the virus concentration in these preparations is high indicates that these crystals are composed of the same material as those obtained by Stanley.

It was found that suspensions of the visible crystals in ammonium sulfate solution produced stream double refraction and that colloidal solutions of the crystals in buffers also showed this phenomenon. As much as 96 parts of buffer solution could be added to 1 part of the suspension of crystals before the solution reached the critical dilution. (The critical dilution is that dilution at which stream double refraction becomes undetectable.) By means of the first order red plate of the polarizing microscope it was found that the vibration direction of the slow ray of polarized light was always parallel to the direction of flow. This relation has also been observed in unpurified virus preparations. If these crystal preparations are pure virus, as many assume, it must be concluded that the virus can exhibit stream double refraction and, when in solution, is probably composed of submicroscopic rod-shaped particles.

Determinations were made of the critical dilution and active virus concentration in solutions of both of the crystalline preparations and in unpurified virus. The influence of pH on critical dilution and on active virus concentration was also determined. The number of local lesions produced on *Nicotiana glutinosa* L. was used as an indicator of active virus concentration. It was found that a given sample of virus produced approximately 14 per cent. more local lesions when at pH 7 than at pH 5.6. Conversely, a given sample of virus at pH 7 had a critical dilution approximately 36 per cent. lower than at pH 5.6. In other words, the number of local lesions produced was higher and the stream double refraction lower at pH 7 than at 5.6. These relations were found to hold for unpurified virus as well as the crystal solutions. As a hypothesis to explain this relation we would suggest that the virus is peptized at the higher pH and that more particles are therefore available to cause local lesions. To account for the lowered stream double refraction at pH 7 we would suggest that the refractive index of colloidal particles is probably lower at pH 7 than at 5.6; this should decrease the stream double refraction.

When stream double refraction is being used to determine the concentration of active virus the unknown and control should, as may be inferred from the above results, always have the same pH.

When solutions of crystals were diluted to the critical dilution the solution of Stanley crystals produced about twice as many local lesions as the solution of "C" crystals. When a critical dilution of unpurified control virus was compared with those of crystal solutions the solution of Stanley crystals produced an average of 24 per cent. less and the solution of "C" crystals 57 per cent. less lesions than did the unpurified virus. If the crystal preparations are pure, these results indicate that a significant portion of the virus in the crystals has become inactive during the purification process and that this inactivation is greatest in the "C" preparations.

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GENES AFFECTING RESPONSE OF NICOTIANA TABACUM HYBRIDS TO TOBACCO-MOSAIC VIRUS

IN *Nicotiana tabacum* L. and *N. paniculata* L. tobacco-mosaic virus (tobacco virus 1, *distorting* strain) causes a mottling-type disease, whereas in *N. rustica* L. and *N. glutinosa* L. the same virus causes necrosis. In a recent paper,[1] it was reported that a dominant gene, controlling necrotic type of response, was transferred from *N. rustica* to a self-fertile derivative of *N. paniculata* by hybridization of the two species, followed by repeated backcrosses to the recessive-type parent, and eventual self-pollinations. In the derived strain of *N. paniculata,* infection induced a necrotic type, instead of a mottling-type, disease. This gene has now been carried from the necrotic-type strain of *N. paniculata* to plants of $[(N.\ paniculata \times N.\ tabacum) \times N.\ tabacum] \times N.\ tabacum$. There were considerable deviations from 1 : 1 ratios of necrotic-type to mottling-type plants in the backcross generations.

A similar gene for necrotic-type response has been transferred from *N. glutinosa* to three generations of hybrids with *N. tabacum*. All plants gave a necrotic type response in the first generation hybrid *N. tab*

[1] F. O. Holmes, *Phytopath.*, 26: 1007, 1936.

cum × *N. glutinosa;* similar F_1 plants have been produced and tested several times in the past.[2] All plants of this first hybrid generation have proved sterile. Because of this sterility, transfer of the gene to further generations was accomplished only by the use of *N. digluta* (fertile amphidiploid *glutinosa-tabacum*). There was uniform necrotic-type response in all plants of the generation *N. digluta* × *N. tabacum.* Segregation occurred in the subsequent backcross generation (*N. digluta* × *N. tabacum*) × *N. tabacum,* mottling-type plants being present in excess of expectation.

It is not yet known whether these necrotic-type genes characteristic of *N. rustica* and *N. glutinosa* can be incorporated in strains of *N. tabacum.* The work here reported is being continued with a view to securing an answer to this problem, because it is believed that tobacco mosaic would be unable to maintain itself in tobacco varieties bearing these genes, and that this disease, now prevalent in such other crops as tomatoes and peppers, might disappear if the virus reservoir in tobacco were eliminated or considerably reduced.

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A VASOPRESSOR LOCAL ANESTHETIC[1]

ONE of the disadvantages of procaine (novocaine) and its known relatives is that they tend to dilate the peripheral vessels. They cause a pronounced fall in blood pressure[2,3,4] as does cocaine,[5] in the ordinary concentrations.

We report the discovery of a new local anesthetic which is vasopressor.

The action of cocaine is dependent upon the presence of a nitrogenous nucleus, an esterified carboxyl and a benzoyl group. The non-alkaloidal local anesthetics owe their action to the benzene nucleus, a carboxyl esterification, and the presence of an amino group para to the above carboxyl.

On these assumptions the search for ideal local anesthetics has proceeded in two directions: (1) derivatives containing a cyclic nitrogen, and (2) derivatives of the amino and oxyamino benzoic alkyl ester type.

Koller[6] first discovered the anesthetizing effect of cocaine on the tongue and in the eye in 1884. Einhorn[7] produced local anesthesia in 1899 by esters of aminobenzoic acid. He introduced procaine, better known as novocaine (p-aminobenzoylbetadiethylaminoethanol), in 1905.

In 1903, Braun reported that the anesthetic effect of cocaine is greatly enhanced by the addition of epinephrine,[8] which is similarly efficient with procaine. Procaine dilates the blood vessels and hastens the exit of the anesthetic from the site of action. With epinephrine the duration of anesthesia is prolonged for over an hour; thus the concentration of the anesthetic can be considerably lowered; the danger of poisoning is also decreased. These results are due to vasoconstriction produced by epinephrine, which practically arrests absorption into the circulation. On the other hand, the nervousness induced by epinephrine in hypersensitive individuals is objectionable; further, it may make them susceptible to cocaine collapse. The epinephrine combination is useless on the intact cornea and for intravenous and subdural injections.[9] The greatest use of the epinephrine combination is in operations involving bleeding; although cocaine is somewhat hemostatic, procaine and the other known synthetic derivatives tend to increase bleeding.

Thus epinephrine is used with all the local anesthetics of *both* types to prevent general absorption and combat the depressor effect of the anesthetic.

In 1931, under the supervision of Professor Nelson and Dr. Powell, of the Department of Chemistry of Columbia University, we began the preparation of a compound that would combine the actions of epinephrine and of procaine. After discarding many such drugs because of undesirable effects we have finally synthesized alpha (3, 4-dihydroxyphenyl) beta (para-aminobenzoylbetadiethylaminoethanol) alphaethanone-hydrochloride, designated for brevity as *epicaine,* which is both a local anesthetic and vasopressor.

We have shown that sympatheticomimicity is greatest in a compound in which the phenyl-hydroxyls are in the 3, 4-position, there is a two-carbon side-chain, a beta-carbon hydroxylated, and an alpha-carbon hydrogen substituted by some indifferent molecule, preferably an amine (but not necessarily so), and, where all these are present, a levorotatory isomer.[10] Our new compound contains these as well as the requisites enumerated above for local anesthesia.

By Rider's method[11] using the frog's sciatic plexus

[2] H. A. Allard, *U. S. Dept. Agr. Bull.,* 40, 1914; J. Johnson, *Am. Jour. Bot.,* 23: 40, 1936; F. O. Holmes, *Phytopath.,* 24: 984, 1934.

[1] From the DeLamar Institute of Public Health, College of Physicians and Surgeons, Columbia University.

[2] Roth, *Hyg. Lab. Bull.,* 109, 1917.

[3] Roth, *Jour. Pharm. and Exp. Ther.,* 9: 352, 1917.

[4] Osborne (to be published).

[5] v. Anrep, *Arch. ges. Physiol.,* 21: 38, 1880.

[6] Koller, *Sitb. Wien. Akad., Math. N. W. Kl.,* Nov., 1884.

[7] Einhorn, "Annalen d. Chemie," 1899.

[8] Braun, "Local Anesthesia," 1914.

[9] Sollman, *Jour. Pharm. and Exp. Ther.,* 11: 1, 9, 69, 159, 1918.

[10] Mulinos and Osborne, *Proc. Soc. Exp. Biol. and Med.,* 32: 1344, 1935.

[11] Rider, *Jour. Pharm. and Exp. Ther.,* 39: 329, 1930.

we demonstrated the ability of *epicaine* to produce definite sensory anesthesia within one minute in a ¼ per cent. strength. We further studied the cat's blood pressure, the uteri of the guinea pig and cat, the gut of the cat, rabbit and monkey, the excised frog's eye and the pupil in the intact cat. In all these the effect was sympatheticomimetic in type.

A more complete study of the pharmacological actions of this drug is now in progress and will be reported in the near future.

RAYMOND L. OSBORNE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DIFFERENTIAL STAINING FOR LIVING AND DEAD CELLS

IN a series of investigations on the mechanism of cellular death with the epidermal cells of *Allium cepa*, I used as a method of differential diagnosis of living and dead cells either the classical Ruzicka's[1] stain (methylen blue and neutral red) or some staining mixtures proposed by later investigators, as, for example, Becquerel's[2] stain (methylen blue, neutral red and Bismarck brown). With these stains the difference in color between the living and the dead cells is often sufficient for a reliable diagnosis of death, but it is never very "contrasty," and most of the time one wishes for a more definite criterion. In search of sharper contrast I tried the simple method of first using a stain which would penetrate both the living and the dead cells and afterwards of applying a reagent which would enter the dead cells only and modify in them alone the color of the stain. The results were, as far as contrasts are concerned, beyond all expectation.

The procedure is as follows: A piece of the lower epidermis of the scale of the onion bulb is peeled off and placed, cutin side down, on a slide. A drop of a .5 per cent., slightly alkaline, aqueous solution of neutral red is deposited on the piece of epidermis and left there for 2 minutes; then it is blotted off and replaced by a drop of a .4 per cent. potassium hydroxide solution, which is immediately removed (also with a blotter); then the preparation is washed with tap water. The living cells take with that treatment a bright cerise red color, while the dead cells are of an intense orange yellow. The contrasts are violent. There are intermediate tints which correspond to the dying cells.

A cell treated with a .4 per cent. solution of KOH may stay alive for hours (if the piece of epidermis is to be observed without cover-slip, put its cutin side up, to avoid evaporation). Lower concentrations of KOH can be used, but they should be applied for a longer time; higher concentrations up to 1 per cent. were also used successfully; above 1 per cent. they become too injurious, but they are not instantly lethal up to 2.5 per cent.

With solutions of neutral red weaker than .5 per cent., the staining process requires a longer time.

The correspondence between the vitality of the cells and their color has been ascertained by testing cells of a given tint for their ability to plasmolyze, their ultra-violet absorption (Luyet and Gehenio's[3] method), and their permeability to various vital and non-vital stains.

Paradoxical as it may seem, the living cells become redder when the action of KOH is prolonged. This is probably due to the production of an "acid of injury" within the cell.

The method employed has been found successful particularly with cells which possess a well-developed vacuolar system. This is consistent with the fact that neutral red, as a vital stain, acts specifically on the vacuome (*cf.* Guillermond[4]).

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THE PREPARATION OF FINE FILAMENTS

THE special article entitled "Simplified Preparation of Microscope Cross Hairs"[1] by A. Wilson Footer indicates a most important method for the easy production of fine filaments of desired size. The dissolving of the silver coating on fine (Wollaston) wires of 0.0001 inch in diameter or 0.00005 inch in diameter and the securing of the core wire intact is an operation with which only the skilled technician is likely to have success.

However, using the commercial adhesive (I understood this to be Duco Household Cement, 10-cent tube), it is possible after a few minutes' experimentation to draw out with the aid of a probe short filament sections, having diameters as small as 0.00006 inch, which can be easily mounted on grids.

Measurement of exact diameter of a section of the filament may be made with a filar micrometer.

JOSEPH B. FICKLEN

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[1] V. Ruzicka, *Pflügers Arch.*, 107: 473, 1905.
[2] P. Becquerel, *Comptes Rendus Ac. Sc.* 176: 601, 1923.
[3] B. J. Luyet and P. M. Gehenio, *Biodynamica*, No. 1[illegible] 1936.
[4] A. Guillermond, "Les Constituants Morphologiques du Cytoplasme: Le Vacuome," p. 10. Paris, 1935.
[1] SCIENCE, 84: 490, 1936.